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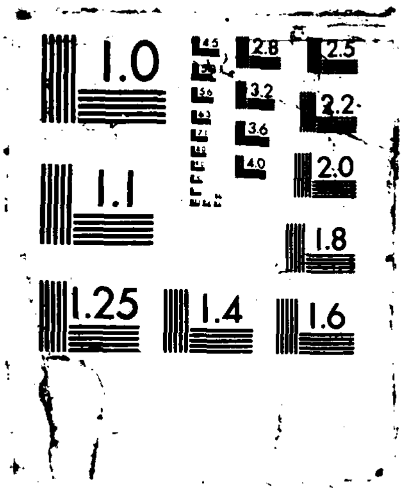
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REPORT SAPEO-CDE-IS-87010

CHEMICAL STOCKPILE DISPOSAL PROGRAM

RISK ANALYSIS OF THE ONSITE DISPOSAL OF CHEMICAL MUNITIONS

AD-A193 354

AUGUST 1987

PROGRAM EXECUTIVE OFFICER-PROGRAM MANAGER FOR CHEMICAL DEMILITARIZATION

ABERDEEN PROVING GROUND, MARYLAND 21010-5401

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This document has been prepared for the U.S. Army to support the Final Programmatic Environmental Impact Statement for the Chemical Stockpile Disposal Program. This report describes the results of a comprehensive probabilistic assessment of the frequency and magnitude of chemical agent release associated with storage, handling, onsite transportation and chemical demilitarization plant operations at eight U.S. Army installations. Both internal accident initiators (e.g., human error) and external accident initiators (e.g., earthquakes) were analyzed.

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RISK ANALYSIS OF THE ONSITE DISPOSAL OF CHEMICAL MUNITIONS

by
GA TECHNOLOGIES INC.

Prepared under
Contract DAAA15-85-D-0022/0008
for the U.S. Army
Office of the Program Executive Officer –
Program Manager for Chemical Demilitarization
Aberdeen Proving Ground, Maryland

GA PROJECT 3813
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LIST OF ABBREVIATIONS

AAF	Army Air Field
AMC	Army Materiel Command
ANAD	Anniston Army Depot
APG	Aberdeen Proving Ground
BCS	bulk chemical storage
BDS	bulk drain station
BRA	brine reduction area
BSA	buffer storage area
BSR	burster size reduction
CAMDS	Chemical Agent Munition Disposal System
CASY	chemical agent storage yard
CCDF	complementary cumulative distribution function
CHE	cargo handling equipment
CONUS	continental United States
CSDP	Chemical Stockpile Disposal Program
DARCOM	U.S. Army Materiel Development and Readiness Command
DATS	drill and transfer system
Decon	decontaminate/decontamination
DFS	deactivation furnace system
DoD	Department of Defense
DPE	demilitarization protective ensemble
DPG	Dugway Proving Ground
DUN	dunnage incinerator
ECR	explosive containment room
ECV	explosive containment vestibule

EIS	environmental impact statement
EMP	electromagnetic pulse
EPA	expected peak acceleration
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FMEA	failure modes and effects analysis
GA	GA Technologies Inc.
HAZOP	hazard and operability analysis
HF	handling operation at the facility
HC	handling operation related to onsite transportation
HP	high pressure
H&R	H&R Technical Associates, Inc.
HRA	human reliability analysis
IE	initiating event
JACADS	Johnston Atoll Chemical Agent Disposal System
LASH	lighter aboard ship
LBAD	Lexington-Blue Grass Army Depot
LIC	liquid incinerator
LPF	leakers processing facility
LPG	liquified propane gas
MDB	munitions demilitarization building
MDM	multipurpose demilitarization machine
MDE	mine demilitarization equipment
MHA	munitions holding area
MHI	munitions holding igloo
MIG	mine glove box
MIN	mine machine
MITRE	The MITRE Corporation
MLD	master logic diagram

MMI	Modified Mercalli Intensity
MPF	metal parts furnace
NA	not applicable
NAAP	Newport Army Ammunition Plant
NDC	National Destruction Center
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
OFC	offsite transport container
ONC	onsite transport container
OPMCM	Office of the Program Manager for Chemical Munitions
ORNL	Oak Ridge National Laboratory
PAS	pollution abatement system
PBA	Pine Bluff Arsenal
PEO-PM Cml Demil	Program Executive Officer-Program Manager for Chemical Demilitarization
PI	periodic inspection
PM	periodic maintenance
PMD	projectile/mortar disassembly
PRA	probabilistic risk assessment
PUDA	Pueblo Depot Activity
RDC	Regional Destruction Center
RDS	rocket drain system
RSM	rocket shearing machine
SAI	Science Applications International Corporation
SEAOC	Structural Engineers Association of California
SMI	storage monitoring inspection
SNL	Sandia National Laboratory
SSE	safe shutdown earthquake
SSI	safety in storage inspection
ST	spray tank

TC	ton container
TEAD	Tooele Army Depot
TECOM	Test and Evaluation Command
THERP	Technique for Human Reliability Analysis
TOX	toxic cubicle
UBC	Uniform Building Code
UMDA	Umatilla Depot Activity
UPA	unpack area

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FIGURES (Continued)

FIGURES (Continued)

FIGURES (Continued)

FIGURES (Continued)

TABLES

TABLES (Continued)

TABLES (Continued)

TABLES (Continued)

EXECUTIVE SUMMARY

S.1. INTRODUCTION

S.1.1. Background

Under the direction of the U.S. Army Office of the Program Executive Officer-Program Manager for Chemical Demilitarization (PEO-PM Cml Demil), GA Technologies Inc. (GA) and its subcontractors performed a comprehensive assessment of the frequency and magnitude of accidental agent releases associated with various alternatives under consideration for the Chemical Stockpile Disposal Program (CSDP). This assessment was carried out in support of the environmental impact statement (EIS) for this program and addresses only the stockpile of chemical munitions that is currently stored at eight sites in the continental United States (CONUS). The assessment of potential health consequences to the public resulting from accidental releases calculated in this study will be performed in a separate study. These consequences and the GA-evaluated frequencies of the releases leading to these consequences will form the basis of estimates of the potential public "risks" associated with the CSDP alternatives.

The alternatives investigated in this study are as follows:

1. Disposal of the agents and munitions at the eight existing storage sites.

2. Collocation (transportation) and disposal of the munitions at two regional sites.

3. Collocation and disposal of the munitions at a single national site.

4. Partial collocation of the selected stockpiles from Aberdeen Proving Ground (APG) to Johnston Island by water or to Tooele Army Depot (TEAD) by air and from the Lexington-Blue Grass Army Depot (LBAD) to TEAD by air.

5. Continued storage of the munitions at the existing storage sites.

This report addresses the onsite disposal alternative listed above (i.e., item 1). The other alternatives are discussed in separate reports.

Demilitarization of the chemical agent and munition stockpiles requires the construction of facilities and planned activities to store, handle, and transport onsite the chemical materiel; to transport the agents and munitions; to destroy the munitions; and to decommission the disposal facilities. This report addresses each of these activities, other than facility construction and closure, which do not pose risk to the health and safety of the general public from agent release.

S.1.2. Study Objectives and Deliverables

The primary objectives of the study reported in this document were to:

1. Identify events that could initiate the release of agent to the environment (i.e., initiating events).

2. Develop the various sequences of events resulting from these initiators and leading to accidental agent release.

3. Perform a quantitative analysis of the frequency of occurrence of each relevant accident sequence.

4. Characterize the physical state, quantity, and duration of agent released from each accident sequence.

These objectives were accomplished by developing a list of potential accident sequences for each major activity, estimating the frequencies of these sequences, and calculating the magnitudes of released agent associated with these sequences. It should be noted that only accident sequences that survived a conservative screening process, considering both frequency and magnitude of agent release, are included in the deliverables of this project.

S.1.3. Scope of Study

The scope of effort reported in this document, as noted earlier, did not include the evaluation of agent dispersion to the environment and the consequences to the public resulting from such releases. As such, the title of this report is more appropriately that of a probabilistic "release" analysis as opposed to a probabilistic "risk" analysis, since risk is usually defined as the product of frequency and consequence. Therefore, the term "risk," as used in this study, refers to the frequency of accidental agent release and not to the frequency of the agent release consequence to public health.

S.1.4. Plant Description

Demilitarization of the chemical munitions stored at U.S. sites is based on the Johnston Atoll Chemical Agent Disposal System (JACADS) technology. This facility is currently being constructed on the Johnston Atoll in the Pacific Ocean. The demilitarization facility consists of an integrated munitions handling system that can process a variety of munitions types and agents. After disassembly and draining

of the munitions, the agent, explosive materials, dunnage, and metal mass are subjected to different combustion trains where the combustibles are consumed by incineration. All materials are subjected to two-stage incineration, and combustion products are released to the environment through a state-of-the-art pollution abatement system.

Two types of demilitarization plants will be constructed: mixed-munition plants and bulk agent plants. Mixed-munition plants are capable of processing all types of chemical materiel. Bulk plants are designed to process ton containers, bombs, and spray tanks.

To meet the September 1994 deadline for the destruction of the chemical agent stockpile, the plants are projected to begin operation during the period between September 1990 and March 1991. The plants will operate five days per week and twenty-four hours per day.

The analysis of plant operations presented in this assessment was based on a plant design which was approximately 35 percent complete. It is recognized that design evolution could have an impact on the results reported herein.

S.1.5. Site Descriptions

There are eight sites in the CONUS where chemical munitions are currently being stored. These sites are: Tooele Army Depot (TEAD), Anniston Army Depot (ANAD), Aberdeen Proving Ground (APG), Lexington-Blue Grass Army Depot (LBAD), Newport Army Ammunition Plant (NAAP), Pine Bluff Arsenal (PBA), Pueblo Depot Activity (PUDA), and the Umatilla Depot Activity (UMDA).

TEAD is located in north central Utah. A prototype demilitarization plant, the Chemical Agent Munitions Disposal System (CAMDS) facility, is located at this site. The site currently stores a wide variety of chemical munitions and bulk agent containers of mustard and the nerve agents, GB and VX.

ANAD is located in northeast Alabama. The chemical munitions stockpile at ANAD consists of all chemical munitions types except for bombs, spray tanks, and 8-in. projectiles filled with VX.

APG is located in Maryland near the head of the Chesapeake Bay. APG is comprised of two general areas, the Aberdeen area and the Edgewood area where the chemical munition storage facilities are located. Only mustard-filled ton containers are stored at APG.

LBAD is located south of Richmond, Kentucky. The chemical munition stockpile at LBAD consists of 8-in. projectiles, 155-mm projectiles, and M55 rockets.

NAAP is located west of Indianapolis, Indiana. The chemical munitions stockpile is stored there in a single warehouse and consists of containers of VX.

PBA is located southeast of Little Rock, Arkansas. The stockpile at PBA consists of M55 rockets, land mines, ton containers, and some 4.2-in. mortar projectiles.

UMDA is located in northeastern Oregon. The stockpile at UMDA consists of 155-mm and 8-in. projectiles, M55 rockets, M23 land mines, bombs, spray tanks, and ton containers.

S.2. STUDY APPROACH

The risk analysis presented in this report combines the structured safety analysis detailed in MIL-STD-882B (Ref. S-1) and the probabilistic approach outlined in NUREG/CR-2300 (Ref. S-2). The first reference requires that hazards analyses be performed to assess the risk involved during the planned life expectancy of a system. It also provides guidance on the categorization of hazard severity and of probability as a means of identifying which hazards should be eliminated or reduced to an acceptable level. The second reference serves as a guidebook for the risk assessment of nuclear power plants.

Risk assessment can be defined as the quantification of an undesirable effect in probabilistic terms. Relative to the health and safety of the public, the effects of interest are injuries and deaths. Risk assessment has been utilized in various industries for some time. Insurance companies have long used actuarial data for statistical evaluations to justify differences in the insurance premium paid by persons in different "risk" categories. The risk assessments performed for nuclear power plants, on the other hand, are examples of major industry efforts to quantify risks of low-frequency events for which no good actuarial data exist. The nuclear power plant risk assessments have become models for other industrial risk assessments.

S.2.1. Risk Assessment Methodology

Probabilistic risk assessment (PRA) is a systematic, disciplined approach to quantifying the frequency and consequences of events which can occur at random points in time. In its application to the various chemical munition disposal alternatives currently under consideration, PRA provides a comprehensive framework for estimating and understanding the risks associated with the storage, handling, transportation, and demilitarization activities associated with these alternatives. By

applying this methodology to each alternative in a consistent and uniform manner, a statement of the relative risk of these alternatives can be made. Because of the significant uncertainties in the data used to quantify the frequency of occurrence of various accident sequences and the magnitudes of the associated agent releases, extreme caution must be used when addressing the absolute risk associated with each disposal option.

In simplistic terms, the PRA process focuses on answering the following three basic questions:

1. What can go wrong?
2. How frequently is it expected to happen?
3. What would be the associated consequences?

The remainder of this summary describes how these questions are addressed in the risk assessment of the chemical materiel disposal program. In this study, the estimation of consequences is limited to the magnitudes of agent release for each sequence.

S.2.1.1. Identification of Initiating Events. The first step in a probabilistic risk assessment is the identification of initiating events which, by themselves or in combination with additional failures, can lead to the release of agent to the environment. Initiating events are identified for each of the demilitarization activities. Such events generally fall into two broad categories known as "internal" events and "external" events. Internal events originate within the activity and are caused by human error or random equipment failure. Examples of such events are the dropping or puncture of munitions during handling operations, and the random failure of a normally operating piece of equipment in the demilitarization process line. The class of events referred to as external includes aircraft crashes and natural phenomena such as earthquakes and storms. In the context of a risk assessment, events such as internal flooding and fires are also considered to be external

events. External events are usually pervasive in nature in that they are assumed to fail redundant equipment that is provided for safe shutdown of the operation and containment of the agent.

S.2.1.2. Accident Sequence Development. Once initiating events are identified, logic models (such as event trees and sequence level fault trees) are developed to display the various paths that the accident can take. For example, an initiating event such as spurious shutdown of an incinerator will not result in a significant release of agent to the environment unless numerous ventilation and automatic shutdown systems fail. In most cases, the probability of failure of multiple systems is so low that the frequencies of such accident sequences are too low to be of any concern. Furthermore, because of inherent system inertia and engineered safety features which are provided, there may be ample time to recover and repair mitigating* systems prior to any release.

As suggested above, operator intervention can influence the course of an accident, and therefore his role must be included in the logic models where appropriate. Of course, operating and emergency personnel also have a significant influence on the potential for and amount of accidental agent release.

S.2.1.3. Human Interactions. Human interactions, or interventions, of interest to the chemical munitions disposal risk assessment fall into one of the following six general categories:

1. Initiation of an accident by committing an error (e.g., a munitions handler punctures or accidentally drops a munition).

*"Mitigation" as used in this report is the act of preventing or limiting the consequence of an accident that has occurred.

2. Test and maintenance actions (e.g., a valve is disabled or left in the wrong configuration following a test or maintenance act).

3. Termination of an accident by correctly implementing established emergency procedures (e.g., an operator terminates agent feed to the liquid incinerator when automatic termination has failed).

4. Aggravation of an accident by taking incorrect action (e.g., a plant operator misdiagnoses the nature of the accident and performs an act which causes the accident to have greater consequences).

5. Termination of an accident by actions which are outside the scope of existing procedures (e.g., based on his knowledge of the plant or process, a plant operator performs an act which is not covered by procedures and terminates or mitigates the accident).

6. Intentional acts to initiate accidents or render equipment in a failed state (sabotage).

Human interactions that fall in the first three categories are modeled either as a separate event heading in the event tree or as an independent event in the fault tree which is used to model and quantify the event in the event tree. Human interactions defined by categories 4 and 5 above are difficult to quantify and as such are not given much attention in a risk assessment.

Acts of sabotage (category 6) are outside the scope of this analysis and will be addressed elsewhere.

S.2.1.4. Agent Release Characterization. The consequences of an agent-release event are dependent on the type of agent, the magnitude of the release, the mode and duration of the release, the dispersion of the agent to the environment, the demographic characteristics of the region impacted by the release, and the toxicity of the dispersed agent at the concentration levels to which members of the public are exposed. The scope of effort reported in this document is limited to the first three characteristics listed above. Agent dispersion to the environment and subsequent effects on humans are addressed elsewhere in a separate report.

The characterization of agent release required a systematic review of the potential modes of agent release from its normal confinement. The first result of this review was the separation of the accident scenarios into two categories: (1) scenarios that occur while the agent is contained in the munition; and (2) scenarios that occur after the agent is separated from the munition. For the munition-dependent accident scenarios, the agent release mechanism is dependent on the particular mechanical, thermal, and explosive behavior of the munition, assuming the occurrence of an initiating event such as dropping during handling or aircraft crash, as well as the confinement which is provided, if any. Scenarios included in the second group are limited to those which occur during the actual demilitarization process (i.e., plant operations).

After determining that agent could be released in a particular accident sequence and that the frequency of that sequence exceeded the threshold screening frequency, an analysis was performed to identify the possible paths by which the agent could be released to the environment and to estimate the quantity of agent released.

S.2.1.5. Sequence Screening. The implementation of PRA methodology in terms of event trees can produce a large number of potential accident sequences. In order to reduce this to a manageable number to focus on the critical scenarios for analysis, the accident sequences are screened

for frequency or consequence. By using conservative values for the conditional probabilities of event tree branches, it is possible to show that many of the possible sequences are of sufficiently low frequency (e.g., less than 10^{-10} per year) that they need not be addressed further. In addition, if an accident sequence has a frequency greater than the threshold screening frequency but results in an insignificant release of agent* to the environment, it can also be eliminated from further consideration. The accident sequences contained in this report have been subjected to both types of screening.

S.3. RESULTS

The analysis of the potential for agent release to the atmosphere from accident scenarios related to the onsite disposal option included the following major activities: (1) storage, (2) handling activities associated with the transport of munitions, (3) onsite transportation, and (4) plant operations associated with the demilitarization of munitions. This section discusses some of the accident probability and agent release results associated with these activities.

The results of the analysis of the various activities encompassing the onsite disposal option cannot be presented in the same units, i.e., annual frequencies, because of the possible divulgence of classified information. This is only possible for some storage and plant operation accident scenarios. For accident scenarios related to the handling activities at the different sites, the unclassified portion of the probabilistic analysis is given in terms of frequency of accidents per pallet of munitions (or as a container of munitions). For onsite transportation accidents, the basic results are reported in terms of

*Less than 14 lbm of mustard; less than 0.4 lbm of agent VX; and less than 0.3 lbm of agent GB. These quantities represent the minimum quantities of agent release that would result in a lethal dose of agent at 500 m for the most limiting release modes (Ref. S-3).

accident frequency per vehicle mile. These probabilities/unit are then multiplied by the number of handling operations or vehicle miles traveled during the stockpile disposal program.

The evaluation of the actual risk to the public and environment requires agent dispersion calculations which are not in the scope of the study reported here. Despite this limitation, the results discussed herein still provide useful insights on the contributions of the various disposal activities to the risk of an agent release. These insights are discussed below.

S.3.1. Accident Scenarios During Storage

S.3.1.1. Internal Events. There were no significant internal event initiators of accidents during storage at the disposal site before movement to the demilitarization facility. Per unit operation, forklift drop accidents occur more frequently than forklift tine punctures. Also, the use of a lifting beam instead of a tine leads to an order of magnitude decrease in drop frequency.

S.3.1.2. External Events. These events involve accidents caused by natural phenomena or human activity affecting munitions in storage igloos, open storage areas, holding areas, or warehouses. If these are assumed to be full of munitions, the agent inventories range up to 100, 1000, and 2000 tons, respectively, for storage igloos, open areas, and warehouses. The most frequent external accidents having significant release involve mild intensity earthquakes or small airplane crashes (order depending on site). Amounts of available agent inventories released in these events are on the order of fractions of one percent or less (munition punctures, drops, etc.).

The largest releases occur for a large aircraft crash, a meteorite strike, or a severe earthquake, especially when a warehouse (at NAAP, TEAD, or UMDA) is involved. These can result in up to 10 percent of

the agent inventory released for scenarios involving a fire which has the potential (duration) for destroying the entire inventory of an igloo or warehouse. The munitions stored in warehouses contain only VX or mustard which have much slower evaporation rates than GB and hence are not easily dispersed into the atmosphere. Thus, warehouse scenarios involving only spills are not significant risk contributors. The warehouse at UMDA has the potential for the largest release. Meteorite strike-initiated sequence median frequencies are one to two orders of magnitude lower than the aircraft crash-induced sequence frequencies. As expected, munitions stored outdoors are generally more susceptible to large aircraft crashes than those stored in warehouses or igloos, but releases are lower. Both APG and PBA have ton containers stored outdoors, and the aircraft crash probabilities at these sites are somewhat higher than at the other sites. Igloos appear to provide only minimal protection from direct crashes of large planes, but releases are an order of magnitude lower. The releases are more severe if burstered munitions are involved.

S.3.2. Accident Scenarios During Handling

Included in the handling analysis are (1) single munition or pallet movements by hand, forklift, or other equipment; (2) packing or unpacking pallets into transportation containers; and (3) loading and unloading packages from trucks.

The results indicate that dropped munitions, whether in palletized form or not, occur more frequently than either forklift tine puncture or forklift collision accidents. In fact, the frequency of forklift collision accidents which lead to the munitions falling off the forklift is an order of magnitude lower than the drop accidents. Furthermore, the type of clothing an operator is wearing while handling these munitions influence the drop frequency value. An operator wearing Level A clothing is more likely to commit an error that would cause the munition to be dropped than when he is wearing more comfortable clothing.

The results also indicate that spray tanks (in overpacks) have relatively higher drop frequencies than other munitions. This is largely due to the assumption that spray tanks will be lifted and moved to the truck (for loading or unloading) using forklift with tines. The drop frequency using the tines is an order of magnitude higher than with the use of lifting beams.

For bare munitions, the rockets seem to be the most prone to punctures from drops or forklift tine accidents. However, the onsite transport container (ONC) itself also affects the puncture probability. However, bare munitions have higher puncture probabilities than munitions in ONCs. This observation is of course not quite evident in the final results presented because there are more handling operations involving possible drops of ONCs than bare munitions.

Bulk items that are punctured lead to larger releases than other munitions such as projectiles or rockets. Bombs are of concern because they contain GB which evaporates more readily than the other agent types. The agent vapor releases range up to 170 lb (thermal failure of all munitions in an ONC), or up to 10 percent of the available agent inventory.

Within the types of handling accidents, the events designated as HO, which are related to the packaging of munitions in ONCs and their movement from storage (sending sites) to the munitions handling igloo (MHI), predominate over handling accidents related to the facility (HF). This is largely because (1) there are more handling operations involved in the HO accidents, (2) HF accidents generally involve munitions in ONCs, which provides them with some protection from puncture, and (3) HF accidents involving bare munitions occur inside the munitions demilitarization building (MDB) which is designed for vapor containment; hence, including the probability of a detonation which destroys the vapor containment barrier, both the frequency of a release and the release itself are relatively lower.

The frequency results for the handling accidents could not be compared with the accidents from other activities, such as plant operations, because of differences in units. To get some perspective on how they compare on a yearly basis, we can estimate the number of pallets that could be handled based on the plant annual processing rates. For illustrative purposes we calculate the number of bomb pallets that are required to meet the annual plant processing rate as:

$$5.4 \text{ bombs/h} \times 24 \text{ h/day} \times 5 \text{ day/week}$$
$$\times\ 52 \text{ week/yr } /2 \text{ bombs/pallet} = 16{,}848 \text{ pallets/yr} \quad .$$

By multiplying the HCl sequence frequency for TEAD (1.2×10^{-7}/pallet) with the number of pallets/yr, the annual frequency is 2.0×10^{-3}/yr. Thus, handling accidents which lead to significant agent releases (in particular, agent GB) are dominant risk contributors because of the relatively higher annual frequency values. Of course depending on the actual munition inventory, the value of annual frequency may either increase or decrease when converted to the more meaningful per stockpile basis.

S.3.3. Accident Scenarios During Plant Operations

Included in the analysis for this phase are all malfunctions during agent processing/incineration within the MDB or external events affecting drained and undrained agent in the MDB, including those in the unpack area (UPA) (up to 10^4 lb of agent available) and munitions awaiting processing in the MHI, up to 3×10^4 lb of agent available. After unpacking, the munitions are processed by conveyor to the burster removal area, mine punch-and-drain area, projectile mortars disassembly area, rocket and burster shearing machines, mine machine for burster removal, a bulk item drain station, a toxic cubicle (TOX) agent storage tank, furnaces for explosive deactivation, metal parts decontamination, and agent and dunnage incinerators, as appropriate.

S.3.3.1. Internal Events. Because of the engineered safety features provided in the plant design, both the frequency of release and magnitude of release associated with accidents initiated by equipment failure and human error are relatively small. Among the large number of accident scenarios analyzed, the highest frequency scenario (P052) is initiated by an inadvertent feed of an unpunched burstered munition to the dunnage incinerator (10^{-2}/yr for mines; 5×10^{-3}/yr for other munitions). As a result of detonation, one burstered munition inventory is released to the atmosphere as vapor (only up to 15 lb of agent).

The largest amount of agent vapor release occurs for a metal parts furnace explosion (P044) with ventilation failure (one bulk item inventory release, up to 1700 lb). However, this scenario was assessed to have a very low frequency, around 10^{-10}/yr. Another event with up to several hundred pounds of vapor release is P048, munition detonation in the explosive containment room vestibule with subsequent fire spreading to unpacked munitions. However, this scenario also has a low frequency, around 10^{-9}/yr.

S.3.3.2. External Events. Aircraft crashes dominate the external event frequency, and there is little difference between direct and indirect crashes. The small difference is attributed to offsetting effects. Although the indirect crash has smaller conditional probabilities of failures than the direct crash, the risk model utilizes a larger target area for the indirect crash. There is very little distinction in the frequency of aircraft crashes with or without fire, since historical data indicate that there is roughly a 50 percent chance that the crash of an aircraft will involve a fire. The frequency of a crash onto the MDB is considerably larger than that for the MHI because the surface area of the MDB is more than 30 times larger than the MHI.

The frequency of large aircraft crashes is estimated to be higher at ANAD than it is for TEAD. This impacts the regional versus national collocation option. The accident scenario involving the crash of an airplane onto the outdoor agent piping system for the modified CAMDS facility at TEAD has a frequency of about 10^{-8}/yr with up to 55 lb of vapor release. This scenario includes both large and small aircraft crashes. The frequency of small aircraft (including helicopters) crashes is at least two orders of magnitude higher than the frequency of large aircraft crashes at TEAD.

The frequencies of earthquake-induced accident scenarios are generally higher for TEAD than for ANAD since TEAD is located in a region more prone to earthquakes. Sequence P033, which represents an earthquake-initiated munition fall and fire but with the MDB and TOX intact, has the highest frequency (2×10^{-6}/yr for ANAD and 5×10^{-5}/yr for TEAD). This sequence involves the detonation of all munitions (if burstered) in the UPA since the fire is not suppressed in this sequence.

All accident sequences related to tornadoes or meteorites were estimated to occur at frequencies of less than 10^{-10}/yr and thus were screened out.

S.3.4. Accident Scenarios During Transport

S.3.4.1. Onsite Transportation. When munitions at their storage locations are ready for demilitarization, they are transferred into onsite containers and then moved by truck to the MHI. The onsite transport accidents are identified as VO scenarios. The agent available in a truck carrying (four) ONCs ranges up to 7000 lb.

As a result of analysis for both internally initiated events (human error or equipment failure) and externally initiated events, the following conclusions were reached:

1. The ONC package provides a substantial protection from impact and crush forces. The results show that accident frequencies resulting in impact or crush failure are insignificant. This is largely due to the administrative control to be imposed during truck travel which limits truck speed to no more than 20 mph. The impact forces at this velocity are not sufficient to breach the containment.

2. The probability of puncture resulting from truck collision/ overturn is the most important mechanical failure mode.

3. Truck accidents which generate fires are not likely to detonate burstered munitions inside onsite packages, since they provide 15-min protection from an all-engulfing fire. These scenario frequency results are quite low because of the administrative control for limiting the amount of fuel in the truck so as not to exceed a 10-min fire.

4. For tornado-initiated accidents, puncture as a result of truck overturn is the dominant contributor to the sequence frequency.

5. Generation of undue forces during truck accidents that could cause burster detonations has a small contribution to the overall truck transportation risk.

6. The amount of agent spilled or burned during truck accidents resulting in the breach in containment by puncture forces generally involve the agent content of one munition. Up to 10 percent is released as vapor.

7. ONCs can fail when an aircraft crashes into the truck (V06, V07). The entire truckload is involved, and up to 10 percent is released as a vapor. Hence, aircraft crash-initiated truck accidents have the most severe consequences. It should be noted, however, that none of the accident sequences has a frequency greater than 10^{-7}/yr.

S.4. UNCERTAINTIES IN THE ANALYSIS

In assessing the risks associated with the onsite disposal alternative, every effort was made to perform best-estimate analyses, i.e., "realistic" evaluation and quantification of the accident sequence frequencies and associated agent releases. The use of pessimistic or conservative modeling techniques or data for quantification violates the intent of the probabilistic nature of the study. Realistic modeling and quantification permits a balanced evaluation of risk contributors and comparison of alternatives. However, for realistic or best-estimate calculations, the obvious concern is the accuracy of the results. Uncertainty analysis addresses this concern.

S.4.1. Sources of Uncertainty

Since the event sequences discussed in Section S.3 have not actually occurred, it is difficult to establish the frequency of the sequence and associated consequences with great precision. For this reason, many parameters in a risk assessment are treated as probabilistically distributed parameters, so that the computation of sequence frequencies and resulting consequences can involve the probabilistic combination of distributions.

There are three general types of uncertainty associated with the evaluations reported in this document: (1) modeling, (2) data, and (3) completeness.

There exist basic uncertainties regarding the ability of the various models to represent the actual conditions associated with the sequence of events for the accident scenarios that can occur in the storage and disposal activities. The ability to represent actual phenomena with analytical models is always a potential concern. The use of fundamental models such as fault trees and event trees is sometimes simplistic because most events depicted in these models are treated as leading to one of two binary states: success or failure (i.e., partial successes or failures are ignored). Model uncertainties are difficult to quantify and are addressed in this study by legitimate efforts of the analysts to make the models as realistic as possible. Where such realism could not be achieved, conservative approaches were taken.

No uncertainty from oversights, errors, or omission from the models used (e.g., event trees and fault trees) is included in the uncertainty analysis results. Including these uncertainties is beyond the state-of-the-art of present day uncertainty analysis.

The uncertainties in the assignment of event probabilities (e.g., component failure rates and initiating event frequencies) are of two types: intrinsic variability and lack of knowledge. An example of intrinsic variability is that where the available experience data is for a population of similar components in similar environments, but not all the components exhibit the same reliability. Intrinsic variations can be caused, for example, by different manufacturers, maintenance practices, or operating conditions. A second example of intrinsic variability is that related to the effects of long-term storage on the condition of the munitions as compared to their original configuration. Lack of knowledge uncertainty is associated with cases where the model parameter is not a random or fluctuating variable, but the analyst simply does not know what the value of the parameter should be. Both of these data uncertainty types are encountered in this study.

S.4.2. Uncertainties

The sequence frequency results discussed in this report are presented in terms of a median value and a range factor of a probability distribution representing the frequency of interest. The range factor represents the ratio of the 95th percentile value of frequency to the 50th percentile (i.e., median) value of frequency. The uncertainty in the sequence frequency is determined using the STADIC-2 program (Ref. S-4) to propagate the uncertainties associated with each of the events in the fault trees or event trees through to the end result. Some scenarios, such as those associated with tornado missiles and low-impact detonations have rather large uncertainties. The difficulty with tornado-generated missiles lies with the difficulty in accurately modeling the probability that the missile will be in the proper orientation to penetrate the munition and in predicting the number of missiles per square foot of wind. The difficulty with the low-impact detonations lies with the sparse amount of data available and its applicability to the scenarios of interest. In general, uncertainties tend to be large when the amount of applicable data is small and vice versa.

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S-3. Memorandum to C. A. Bolig (GA) from R. B. Perry (PEO-PM Cml Demil), May 6, 1987.

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1. INTRODUCTION

1.1. BACKGROUND

The U.S. Department of Defense is required by Congress (Public Law 99-145) to destroy the stockpile of lethal chemical agents and munitions stored at eight U.S. Army installations in the continental United States (CONUS) and at the Johnston Atoll Army site in the Pacific Ocean by the end of September 1994. The locations of the CONUS sites are shown in Fig. 1-1. The total Army stockpile at these sites is made up of more than 3,000,000 items consisting of rockets, mines, mortars, projectiles, cartridges, bombs, spray tanks, and bulk containers. These munitions contain the nerve agents GB and VX and the blistering mustard agents H, HD, and HT.

The Army has developed a plan for destruction of the chemical munition stockpile. This plan is set forth in the Chemical Stockpile Disposal Concept Plan submitted to Congress in March 1986 and supplemented in March 1987. In this plan, three disposal alternatives are described:

1. Disposal of the agents and munitions at each of the eight existing storage sites.

2. Collocation and disposal of the munitions at two regional sites.

3. Collocation and disposal of the munitions at a single national site.

These three disposal alternatives were also described in a Draft Progammatic Environmental Impact Statement published by the Army in

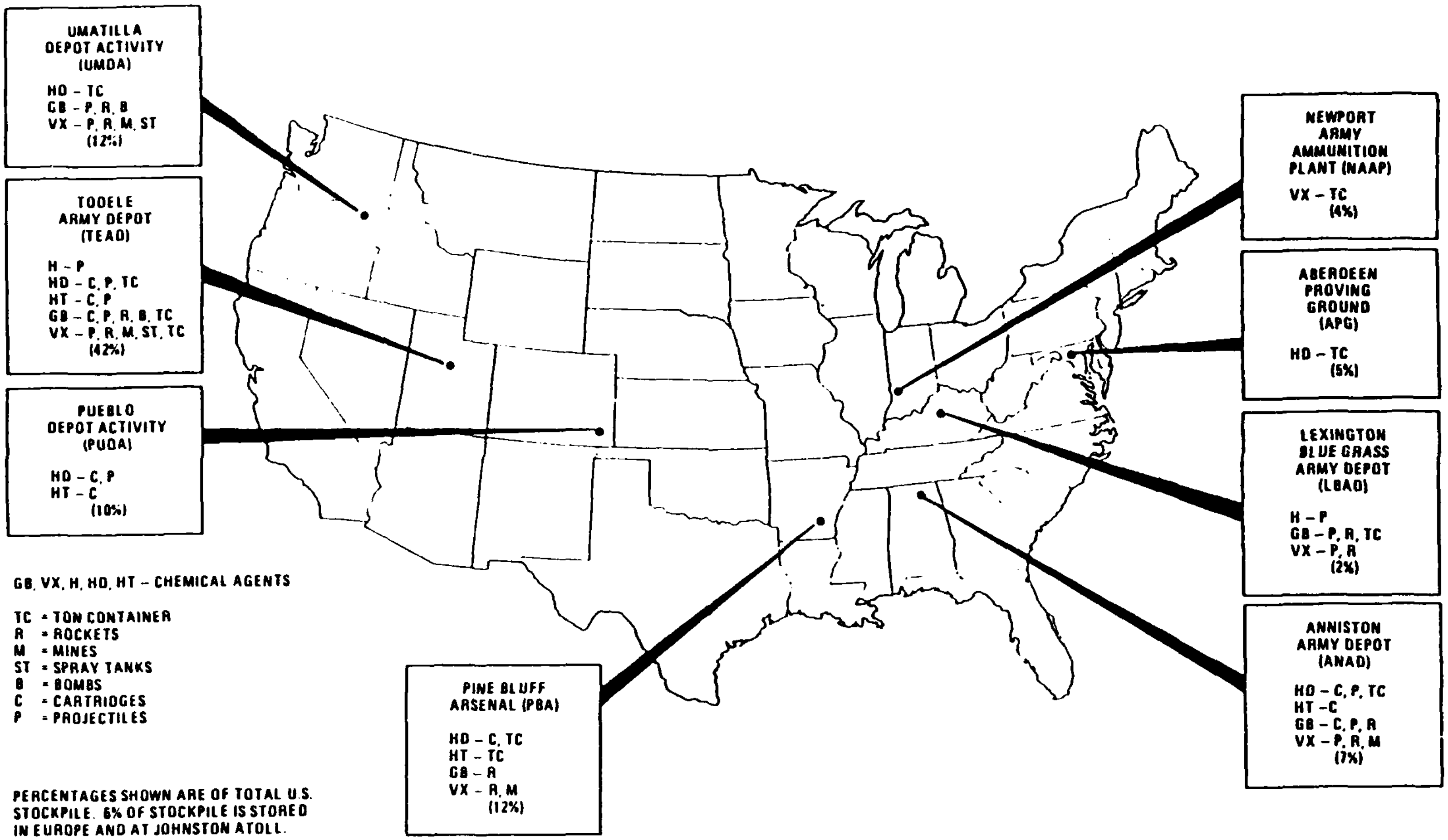

Fig. 1-1. Location of chemical agents and munitions in the U.S.

July 1986. Additionally, it was required that the status quo, i.e., continued storage, be also evaluated as the fourth alternative. As part of the public commentary on this document, requests were made of the Army to consider also the transport of the inventory from Aberdeen Proving Ground to Johnston Island by water or to Tooele Army Depot by air and from the Lexington-Blue Grass Army Depot to Tooele by air.

Under direction from the U.S. Army Office of the Program Executive Officer Program Manager for Chemical Demilitarization (PEO-PM Cml Demil), GA Technologies Inc. (GA) and its subcontractors have performed a comprehensive probabilistic assessment of the frequency and magnitude of agent release associated with activities involving the three disposal alternatives currently set forth in the Chemical Stockpile Disposal Program (CSDP), as well as the continued storage alternative. This assessment has been carried out in support of the environmental impact statement (EIS) for this program and it addresses only the stockpile of chemical munitions which are currently stored at the eight sites located in the continental United States (CONUS).

When combined with an assessment of the consequences (injuries and/or deaths) to the public resulting from the accident sequences and associated agent releases identified and evaluated in this study, the results form a basis for an assessment of public risk. The dispersion of the agent to the environment and the assessment of consequences related to these releases are outside the scope of this study. A consequence assessment has been performed by MITRE Corporation and Oak Ridge National Laboratory for the EIS, based on the releases identified in this document.

This report addresses the onsite disposal alternative identified above. The remaining alternatives are discussed in separate reports.

Previous studies have been utilized by GA as reference bases for this assessment. Quantitative hazards analyses were performed by

Arthur D. Little, Inc. on the disposal of M55 rockets (Refs. 1-1 to 1-5), and qualitative hazards analyses were performed by the Ralph M. Parsons Company on the Johnston Atoll Chemical Agent Disposal System (JACADS) design (Refs. 1-6 and 1-7). In addition, a probabilistic analysis of chemical agent release during transport of M55 rockets has been performed by H&R Technical Associates (Ref. 1-8), and a probabilistic analysis of selected hazards during the disposal of M55 rockets has been performed by Science Applications International Corporation (Ref. 1-9). These studies provided the set of accident scenarios that was compiled in a systematic order by MITRE Corporation (Ref. 1-10 and 1-11). GA, in turn, used these accident scenarios as a starting point in this study.

The analyses performed by Arthur D. Little, Inc. used a technique known as hazard and operability analysis (HAZOP). HAZOP involves a detailed review of plant design to trace all parts and functions of the demilitarization process. For each piece of equipment or pipe run, deviations from normal operating conditions were examined and possible consequences were discussed. Through this approach, potential failure modes leading to agent release outside of the facility were identified. The expected frequencies of occurrence of all agent release sequences identified in the HAZOP were then evaluated using fault tree analysis.

The qualitative hazards analysis performed for JACADS used an approach known as failure modes and effects analysis (FMEA). The severity and probability levels of identified hazards were ranked according to the guidelines in Ref. 1-11.

The transportation studies performed by H&R Technical Associates (Ref. 1-8) used a combined fault tree and event tree approach to assess the frequency of agent release from transportation accidents.

The work performed by Science Applications International Corporation (Ref. 1-9) on the disposal of M55 rockets utilized both event tree and fault tree methodology as used in the PRA of nuclear power plants.

Onsite demilitarization of the chemical munitions stockpile requires the construction of facilities to destroy the contents of the munitions, the handling, onsite truck transportation, and storage of munitions at current storage sites, the destruction of the munitions, and the decommissioning of the constructed facilities. This report addresses each of these activities, except for facility construction and decommissioning.

1.2. STUDY OBJECTIVES AND SCOPE

The primary objectives of the study reported in this document were to:

1. Identify events (for each major activity) that could initiate the release of agent to the environment.

2. Develop the various sequences of events resulting from these initiators and leading to agent release.

3. Perform a quantitative analysis of the frequency of occurrence of each relevant accident sequence.

4. Characterize the form, quantity, and duration of agent release from each accident sequence.

5. Identify accident sequences which make the most significant contributions to risk.

The major deliverables of this effort are a list of potential accident sequences for each major activity, the estimated frequencies of these sequences, and the magnitudes of released agent associated with these sequences. It should be noted that only accident sequences that survived a conservative screening process, involving both frequency and magnitude of agent release, are included in these deliverables.

This report addresses each of the objectives listed above and presents the analysis of this study. The risk analysis includes an evaluation of potential accidents and natural occurring phenomena such as earthquakes and tornadoes. Acts of war, sabotage, and terrorism, which involve intentionally-initiated events, were not included in the scope of this effort.

The term "chemical munitions" is used here to describe both burstered chemical munitions and chemical bulk items. The 4.2-in. mortars refer to the actual 4.2-in. projectile which is fired from mortar cannons or tubes. The 105-mm cartridge and 4.2-in. mortar projectile can either be configured with propellant (i.e., a cartridge) or without propellant (i.e., a projectile). In this study, it was assumed that the propellant and fuze were removed prior to the onset of the disposal program.

1.3. DEMILITARIZATION ACTIVITIES AND SAFETY CONCERNS

Figure 1-2 shows a comparison of the various logistics phases associated with the various munition disposal and storage alternatives evaluated for the EIS. As indicated in this figure, the demilitarization process associated with the onsite disposal alternative can be divided into four general areas of activity: storage, plant operations, handling, and onsite transport. Except for the offsite transport activity, the collocation alternatives involve the same logistic phases. In contrast, only the storage activity is of concern for the continued storage option.

For each of these activities or phases, the hazards of interest are those involving the evaporative release of agent to the environment resulting from spills, leaks, and mechanical failures, and the release of agent to the environment resulting from fires and explosions. The generation of these potential hazards originates with a number of "internal" and "external" initiating events. The number of hazard-initiating event combinations is rather extensive. However, because of the screening process which was used to remove from further consideration the accident sequences whose frequency was low and/or the associated magnitude of agent release was low, the number of individual sequences which are important to risk is relatively small.

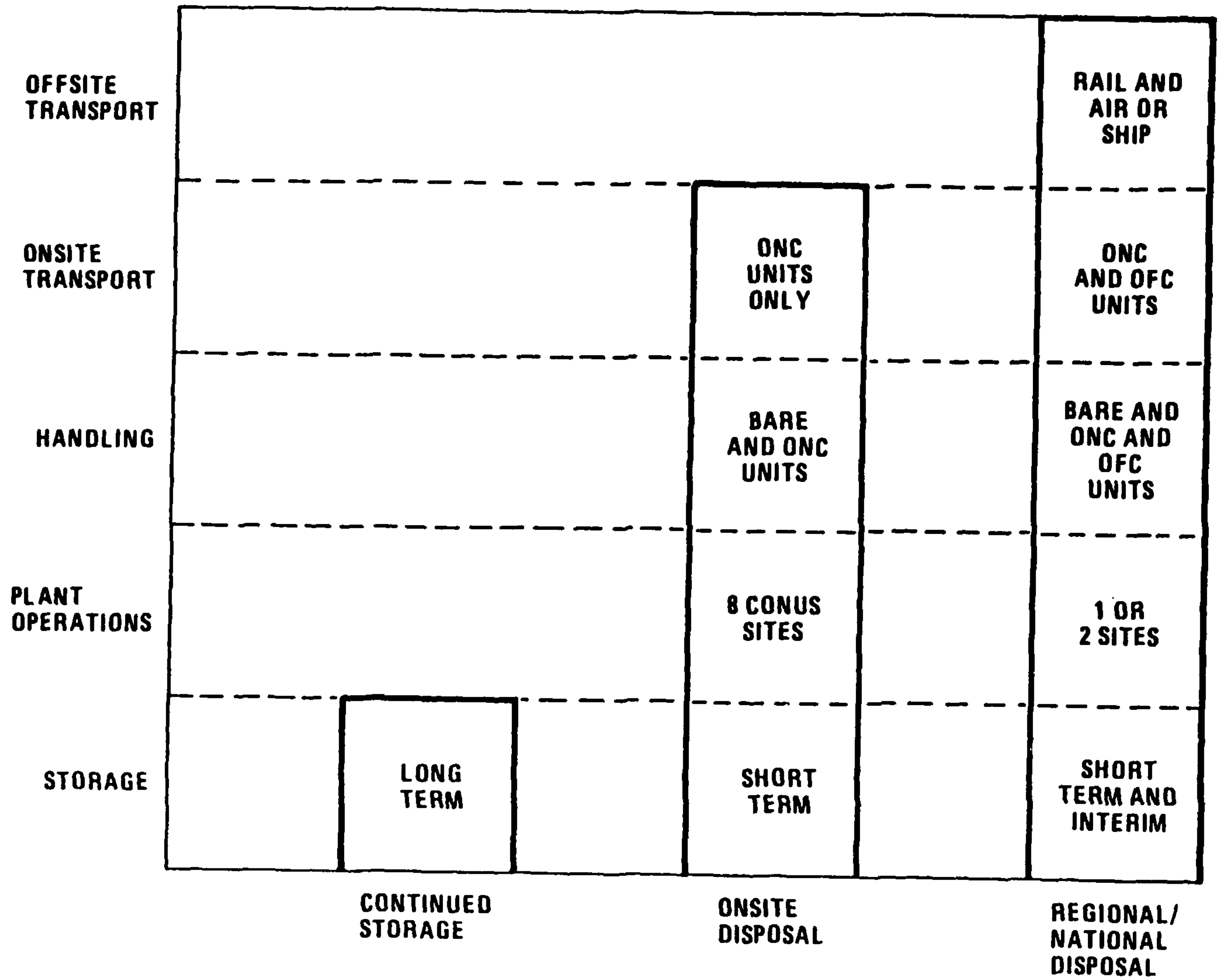

Fig. 1-2. Logistic phases associated with the munitions storage and disposal options

1.4. STUDY ASSUMPTIONS

The risk analysis presented in this report uses an approach that combines the structured safety analysis detailed in MIL-STD-882B (Ref. 1-12) and the probabilistic approach used in the safety analyses of nuclear power plants (Ref. 1-13). Reference 1-12 requires that hazards analyses be performed in order to assess the risk involved during the planned life expectancy of a system. It also provides some guidance on the categorization of hazard severity and probability as a means of identifying which hazards should be eliminated or reduced to a level acceptable to the managing activity.

The risk analysis was performed under the following set of general assumptions:

1. Onsite transportation of munitions will be by truck.

2. Munitions will be stored in their current storage locations and will be transferred to the demilitarization facility (same site) as needed.

3. The baseline process design will be used (i.e., JACADS type facility). At TEAD, some existing process equipment will be used. The design includes a bulk-only facility as well as a mixed munition plant design similar to the JACADS design. The design of the CONUS demilitarization facilities is now approximately 35% complete.

4. Munitions are in good condition during the handling, transportation, and disposal activities.

5. Sabotage or terrorism is not considered.

1.5. REPORT FORMAT

This report is structured as outlined schematically in Fig. 1-3. The structure follows that typically used in comprehensive probabilistic risk assessment (PRA) studies. Following the introduction in Section 1 of this report, Section 2 provides a summary of the methodology used in this frequency of release assessment, including the procedure for accident scenario identification and screening, the approach used for quantifying accident frequencies and characterizing agent release, and the treatment of uncertainties.

Section 3 provides a brief discussion of the various activities involved in the disposal of chemical munitions. This discussion is provided to assist readers in the understanding of the initiating events and accident scenarios that have been identified and are discussed in Sections 4 through 8. This section also discusses site-specific information that is important to a particular site. Appendix D contains additional site information.

The list of accident initiating events which have been analyzed is along with the analysis of their occurrence frequencies are presented in Section 4. These events include accidents from internal causes, such as inadvertent impact during handling, and accidents caused by external events, such as earthquakes or aircraft crashes.

Sections 5 through 8 present the detailed development and analysis of the key accident scenarios resulting from the initiating events.

Section 9 provides the basis for quantification of accident sequence frequencies including munition failure probabilities, the data base used for estimating the probabilities of event-tree top events and fault-tree basic events, and the data used for assessing human error.

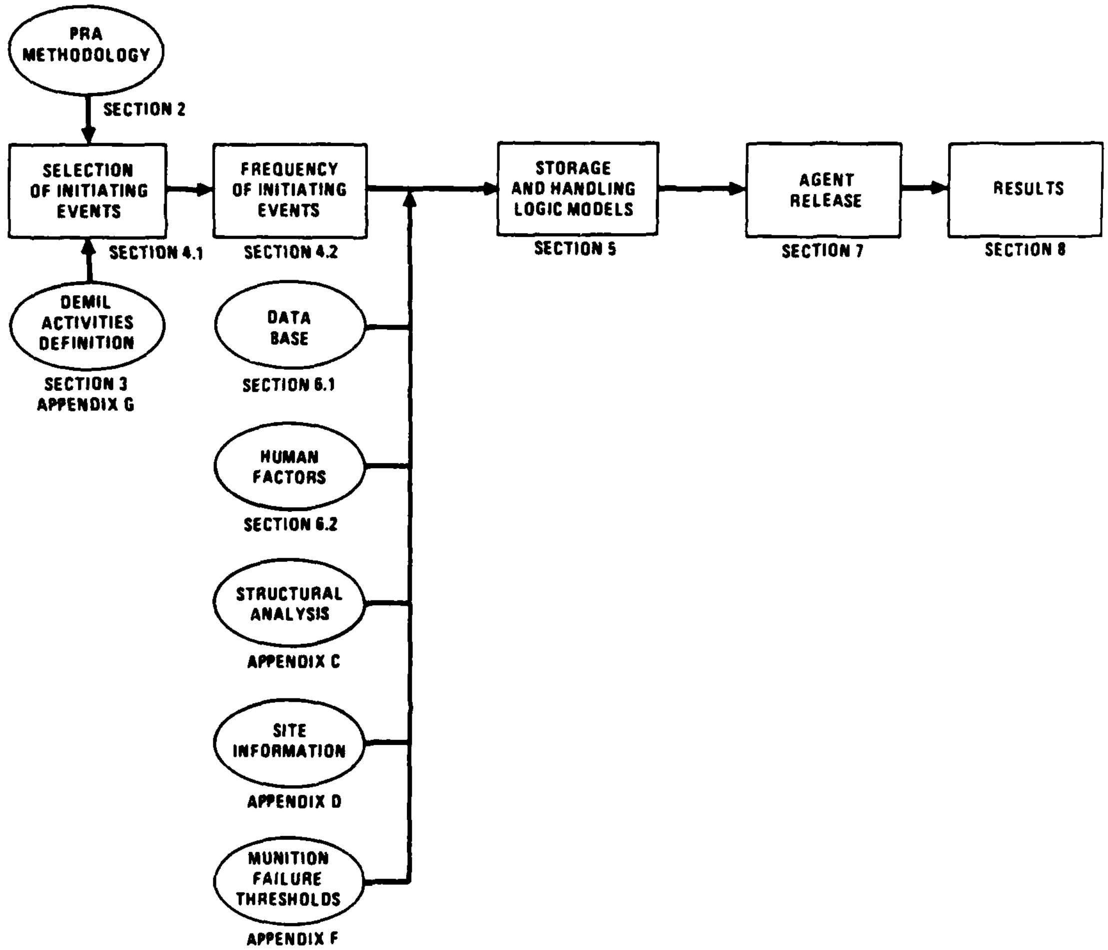

Fig. 1-3. Outline of report structure

The characterization of agent released in the various accident sequences is discussed in Section 10.

Section 11 presents the overall results of the analysis.

Supporting data and calculations for the study are contained in the appendices. References to appropriate appendices are made throughout the body of the report.

1.6. REFERENCES

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2. RISK ASSESSMENT METHODOLOGY

2.1. OVERVIEW

The probabilistic risk assessment (PRA) methodology used in this study is generally consistent with the PRA Procedures Guide (Ref. 2-1) for nuclear power plants. Figure 2-1, adapted from that guide, outlines the risk assessment procedure for this study. Certain specific features of the demilitarization process dictate some different emphasis and treatments from those described in Ref. 2-1. The risk assessment steps corresponding to the procedures in Fig. 2-1 are as follows:

1. Identify accident initiators (initiating events) through information collection, hazards analyses, or the use of master logic diagrams. The initiating events are classified as external if they originate from outside the demilitarization process (such as aircraft crash) and as internal otherwise.

2. Define accident scenarios, i.e., combination of initiating events and the successes or failures of systems that respond to the initiating event. An "accident sequence" is referred to in this report as a specific end point of an accident scenario, which is usually modeled using event trees. An "event tree" is an inductive logic model which traces the sequence of events that can occur following an initiating event.

3. Construct "fault trees" (deductive system logic models) to determine the root causes of individual system failures. The fault tree is reduced to minimal cut sets using Boolean algebra. A "minimal cut set" represents a unique combination of events leading to system failure.

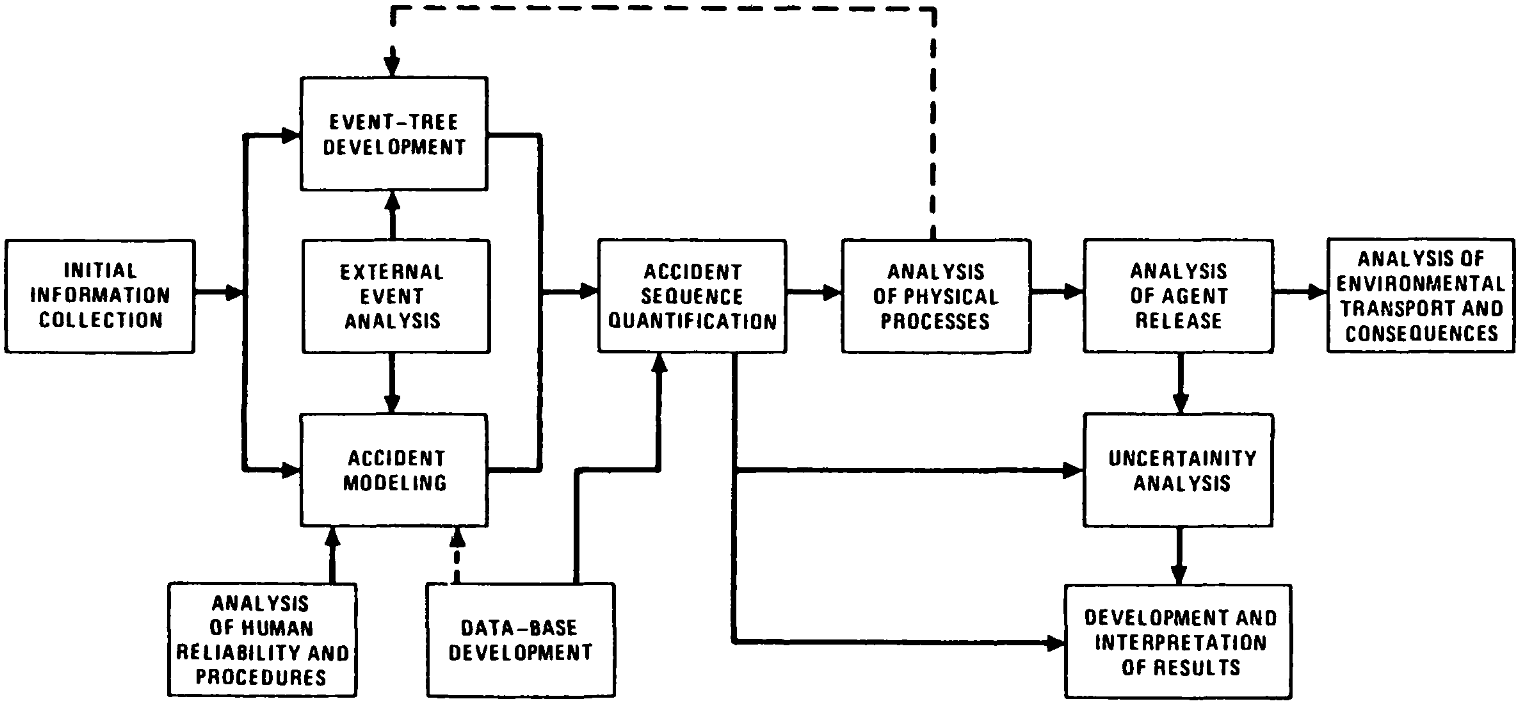


Fig. 2-1. Outline of risk assessment procedure used in this study

4. Assign failure rates or probabilities to events (components or subsystem) modeled in the event trees and fault trees. Quantify the frequencies of occurrence of accident sequences from either the event tree or fault tree by computing the product of the initiating event frequency and the probabilities of the subsequent conditional events in a given accident scenario.

5. Determine the consequences of the accident sequences. In this analysis, the consequence of concern is the amount of agent released to the local free environment. The impact of agent release on the population will be used by others in their CSDP analysis.

6. Evaluate the uncertainties in the data base, and predict the uncertainty in each relevant accident sequence frequency by propagating the top event uncertainties through the event trees.

7. Present the results (i.e., accident scenario frequency and consequence) in a form that will best show those scenarios that are important to risk and will reflect the uncertainties associated with the accident sequence frequency.

2.2. INITIATING EVENTS

An initiating event is a single occurrence or malfunction that has the potential to release one or more agents or to start a sequence of events that could lead to a release. The list of initiating events is developed based on previous demilitarization studies (Section 1.2) and related PRAs such as Waste Repository studies (e.g., Ref. 2-2), in addition to the use of master logic diagrams.

The initiating event list is developed in top-down fashion by structuring a master logic diagram to define a functional set of initiating categories. These categories form a complete set in the sense that any event which leads to agent release must cause at least one of these categories to occur.

Some "common cause initiating events" (e.g., an earthquake) can activate more than one initiating event category and disable controls for release. While there is no way to guarantee that all such events are identified, two areas yield the most significant events. The first includes severe environmental events (such as fire, flood, earthquake, and wind) as well as hazardous activities in the vicinity (such as aircraft patterns). The second area includes malfunctions that can affect multiple controls or barriers for the prevention of release to the atmosphere.

Coincident with the development of the list of initiating events is the assessment of the initiating event frequencies. This is required, first, for subsequent quantification of event trees, since the event initiator is the first event of the tree. Second, it enables screening of the list of initiating events, i.e., events having extremely low frequencies can be eliminated. Where possible, the initiating events are grouped into categories when the subsequent event tree and release analysis development is the same for all initiating events in the category. This grouping is performed by Boolean summation of the occurrence frequencies, accounting for dependencies, if any.

2.3. SCENARIO DEVELOPMENT AND LOGIC MODELS

Given the occurrence of an initiating event (IE), accident scenarios are developed, in many cases using logic models of either event trees, fault trees, or both, to arrive at the various outcomes of the scenario progression. Each of these outcomes, termed a sequence, is associated with (or even characterized by) a certain level of agent release. The basic premise of the risk summation process is that release frequencies (initiating event frequency multiplicatively combined with probabilities of subsequent failures necessary to get the release) of entirely different sequences can be additively combined to get the overall frequency of release. The additive and multiplicative combination is performed using Boolean algebra and accounts for dependencies.

Figure 2-2 shows a sample event tree. In this example, the IE is a vehicle collision, having an estimated occurrence frequency which can be a point estimate or be probabilistically distributed. The IE is the first "top event," and potential subsequent failures represent the other top events or branch points. These top events are in the form of questions, and by convention the upper branch represents the positive answer sequence and the lower branch is the negative answer sequence. Branch split fractions or probabilities are assigned at each of these branch points. These split fractions may be point estimates or probabilistic distributions, and may not be the same for all branch points under a specific top event, depending on prior events. That is, the split fractions represent conditional probabilities.

The frequency of an accident sequence is calculated based on the following equation:

$$F_j = I_j \prod_{i=1}^{n} P_{i,j} \quad , \tag{2-1}$$

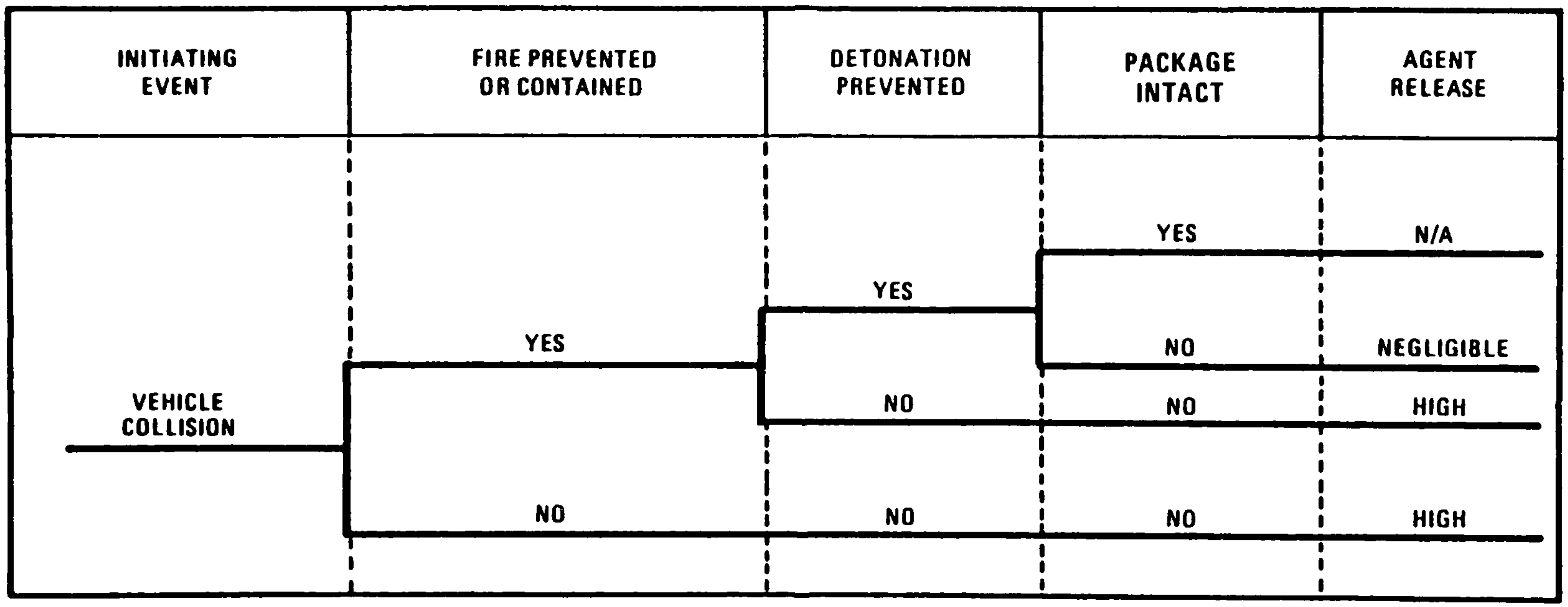


Fig. 2-2. Accident scenario development using an event tree

where F_j = frequency of accident sequence j,

I_j = initiating event frequency,

$P_{i,j}$ = conditional probability of sequence event i following an initiating event, I_j.

Accident frequency and equipment/component failure rate data were derived from various sources, as described in Section 9.

In this study, the event trees are relatively simple in form compared to those developed for nuclear plant PRAs. Most dependencies are modeled explicitly in the event trees by use of conditional branching probabilities which are dependent upon the branch taken for prior events. For example, in an event tree where two consecutive top events represent the availabilities of systems 1 and 2, system 2 might not be called upon unless system 1 fails. This would be shown in the event tree by a dashed line for system 2 in the system 1 success branch, indicating not applicable. Conversely, if system 2 is capable of operating only in conjunction with successful operation of system 1, the dashed line is shown on the system 1 failure (no) branch for system 2 top event. This indicates a guaranteed failure of system 2, given nonoperation of system 1.

For many scenarios, it was found convenient to use fault tree logic for development of the accident progression and quantification of the sequence frequencies. Figure 2-3 depicts a sample fault tree. Logic symbols used in constructing fault trees are defined in Fig. 2-4. The approach taken for treatment of dependencies in the event trees is to identify specific intercomponent and intersystem causes of multiple failures, if any, directly in the fault tree and to make an allowance for those not explicitly identified. A Beta factor method (e.g., Ref. 2-3) is a convenient tool for determining a suitable allowance and was used where appropriate. In this method, multiple failures of redundant components are assumed to occur in a dependent fashion; the

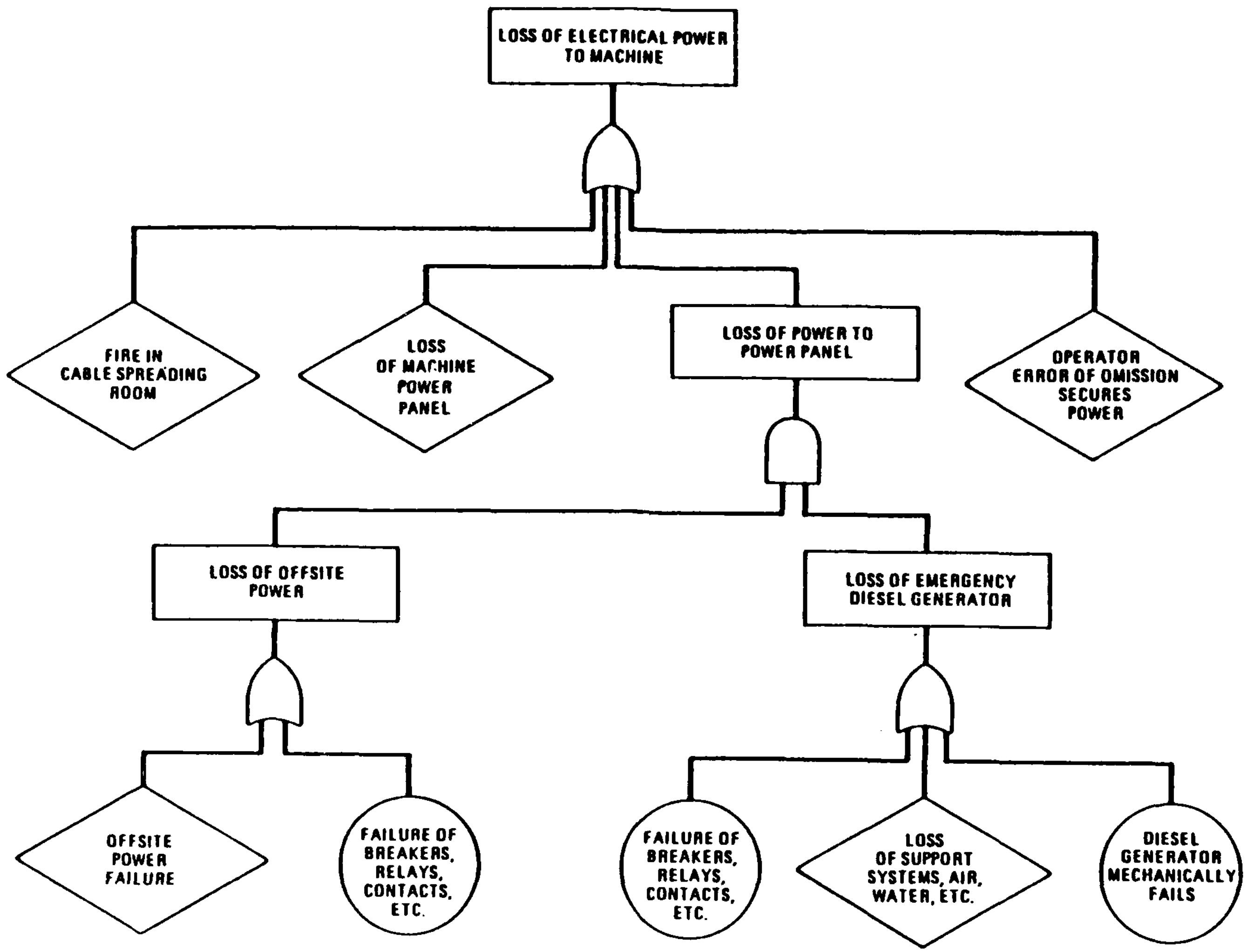


Fig. 2-3. A fault tree model of a power system failure

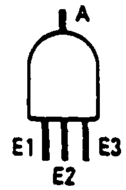
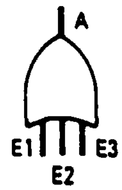
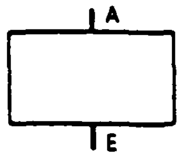
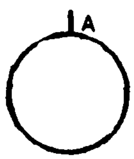
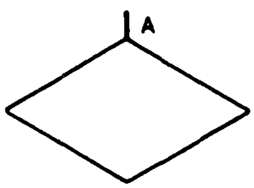
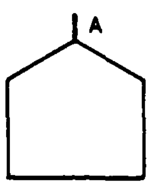
	"AND"	OUTPUT (A) EXISTS ONLY WHEN ALL INPUTS (E) EXIST. THE NUMBER OF INPUTS MUST BE AT LEAST TWO. INDICATES REDUNDANCY. $P(A) = P(E1) \times P(E2) \times P(E3) \times$ ETC.
	"OR"	OUTPUT (A) EXISTS WHEN ONE OR MORE INPUTS (E) EXIST. THE NUMBER OF INPUTS MUST BE AT LEAST TWO. $P(A) = P(E1) + P(E2) + P(E3) +$ ETC.
	"RESULTANT FAULT EVENT"	THE FAULT CONDITION THAT EXISTS WHEN INPUT (E) EXISTS.
	"BASIC INPUT EVENT"	A SPECIFIC FAILURE TO WHICH A FAILURE RATE OR RELATIVE PROBABILITY CAN BE ASSIGNED. OUTPUT (A) EXISTS WHEN THE FAILURE EXISTS.
	"UNDEVELOPED EVENT"	SUBSTITUTE FOR A BASIC INPUT EVENT WHEN THE FAILURE IS NOT TRACED TO A SPECIFIC SOURCE. THIS SYMBOL CAN REPRESENT ANOTHER FAULT TREE AT A LOWER LEVEL WHICH HAS NOT BEEN DRAWN.
	"HOUSE"	THE HOUSE REPRESENTS AN EVENT WHICH IS NORMALLY EXPECTED TO OCCUR OR NEVER TO OCCUR. IT IS TREATED AS A SWITCH ON THE TREE AND IS SET ON OR OFF.
	"TRANSFER"	INDICATES TIE-IN TO A SEPARATE FAULT TREE.

Fig. 2-4. Definition of fault tree symbols

parameter β is defined as the fraction of failures experienced in components that are common cause failures.

Just as there are uncertainties in estimating component failure rates, there are also uncertainties in the β factor. These uncertainties were quantified assuming lognormal distribution for the β factor. The uncertainty distribution accounts for uncertainties due to sparsity of data, as well as those due to classification and the so-called "potential common cause failures." These are events in which one failure actually occurs and additional failures could have occurred under different circumstances, as well as incipient failures and degraded operability states.

In the case where the fault sequence i, given an initiating event, involves a subsystem or equipment failure, the failure probability calculations may involve not only the calculation of the unavailability value (probability of failure per demand) but also the unreliability value (probability of failure while component/equipment is running). In this case, the overall failure probability value for a given equipment or subsystem is calculated using the following equation (Ref. 2-3):

$$P_i = P_{i,d} + (1 - P_{i,d})\, P_{i,r} \quad , \tag{2-2}$$

where $P_{i,d}$ = failure upon demand (unavailability),
$P_{i,r}$ = failure while running (unreliability).

The calculation of component unreliability ($P_{i,r}$) is influenced by several factors: (1) the frequency of periodic maintenance (PM); (2) the use of different failure detection systems; and (3) the various methods used to monitor equipment operation.

For the analysis presented in this report, two options were considered in the calculation of component unreliability. The first option was to consider the periodic maintenance of a component. Thus, when a

component is periodically removed from service for preventative maintenance, the failure probability is dominated by the maintenance interval in addition to the failure rate according to the following equation:

$$P_{i,r} = \frac{1}{\lambda\theta} (1 - e^{-\lambda\theta}) \approx \frac{\lambda\theta}{2} \quad , \tag{2-3}$$

where λ = failure rate,

θ = maintenance interval.

The second option was to consider continuous component surveillance which decreases the failure probability by announcing component failure to the operators concurrent with failure initiation. The repair time required to restore the component becomes an important factor as shown in the following equation:

$$P_{i,r} = \frac{\lambda}{\lambda + \nu} [1 - e^{-(\lambda+\nu)t}] \quad , \tag{2-4}$$

where $\nu = 1/\tau$ mean repair rate (per h),

τ = repair time (h),

t = time interval of interest.

In Eq. 2-5 the failure probability approaches $\lambda\tau$ as the time interval increases and $\lambda\tau$ is small (i.e., $\lambda\tau \ll 1$).

In most of the component failures identified in the fault tree models, the first option is used (i.e., calculating reliability as a function of maintenance interval) and a monthly PM interval is assumed (i.e., maintenance interval of 528 h) for the equipment. This is a conservative approach in deriving the failure probability. If a more frequent maintenance policy is adopted or if experience shows that the component restoration time is much less than the maintenance interval, the failure probability will decrease. However, in view of the nature of the fault tree models, this approach seems justified because the

failure contribution of a particular component is not negated by assuming an unnecessarily low failure probability.

2.4. HUMAN FACTORS

The treatment of intersystem and intercomponent equipment dependencies is discussed above, including how dependencies are taken into account by the logic models. This section describes another kind of dependence--that involving human interaction.

To the extent that human beings design, construct, operate, and maintain the plant, it is impossible to fully isolate the role of human interactions from any of the dependencies discussed above in terms of hardware interactions. Hence, all of the common cause analysis methods described above pertain directly or indirectly to human interactions. The discussion is restricted here to human interactions in the operation and maintenance processes.

The procedure used for analysis of intersystem and intercomponent dependencies caused by human interactions was to include human errors of omission and commission explicitly in the event tree/fault tree models and to use the human reliability methods of Swain (Ref. 2-4) to implement quantification. A starting point for the identification of specific errors is the analysis of operation and maintenance procedures if they have been defined for the event sequence being investigated. This is especially important if operator action is required to effect actuation of a system or a collection of systems. Consideration needs to be given to possible incorrect judgments as to the plant state and subsequent implementation of the wrong procedures. Once these acts are identified and modeled, the problem of determining contribution to risk by operator actions is reduced to assigning the correct human error rate values.

2.5. RELEASE CHARACTERIZATION

The risk associated with each accident scenario requires not only the quantification of the frequency of that scenario but a characterization of the agent release as well. This characterization involves the type and amount of agent released, and the mode duration of the release.

At any given time, there is at least one containment barrier separating the agent from the surrounding environment. Thus failure or loss of integrity of this barrier must occur for agent to be released to the environment.

In general, the accident scenarios interest can be divided into two groups: (1) those scenarios in which the agent is inside the munition (e.g., scenarios involving transportation accidents), and (2) those in which the agent has been removed from the munition (plant operations accident scenarios). For both of these groups there are essentially three types of agent release to the environment:

1. Evaporation from a liquid spill.
2. Releases resulting from detonations.
3. Releases resulting from fires.

Various combinations of these releases appear in many of the scenarios. In addition, depending on the location of these events (e.g., indoor versus outdoor spills), the evaporation rates governing these releases may vary somewhat.

The approach taken for assessing the amount, type, and duration of agent release is based on deterministic models which stem from previous demilitarization safety studies described in Section 1.1. These models are based largely on data but also engineering judgment. They are described in Section 10.1.

Elements of the model include correlations for evaporation release, based on the D2PC computer program. In many cases, the D2PC computer program was used directly to calculate evaporative releases. Other elements include the fraction of burning agent which is released as vapor and the fraction of a detonating munition inventory which is released as vapor. The model relies heavily on data and analysis of munitions failure thresholds, summarized in Appendix F, to determine the extent of munition failures, including the potential for failure propagation of munitions. It is this area where engineering judgment was needed to supplement the data and analysis. Where judgmental factors entered in, they were routinely made in a conservative manner to cover possible uncertainties.

2.6. UNCERTAINTY ANALYSIS

Estimates of failure probabilities derived from various data sources are subject to uncertainties. Data sources do not always specify what failure modes are represented, what environment is applicable, or what is the total statistical population. In some cases, failure data may not be available for a specific event; therefore, data for events that occur under conditions that are similar to the events under consideration are selected as representative. These considerations result in uncertainties that are reflected in the range of possible numerical values for an event.

For events involving equipment failures, a lognormal distribution was assumed to define the uncertainty in the failure probability. The lognormal distribution was explicitly used in Ref. 6-18 and other PRA studies of nuclear power plants because of its mathematical behavior. For the analysis covered in this report, equipment failures and accident initiators that are either man-made or arise from natural causes are assumed to be lognormally distributed.

In the analysis of accident scenario probabilities, the STADIC-2 computer program (Ref. 2-5) was used to combine probability distributions of a series of event sequences which make up an accident scenario. STADIC-2 uses a Monte Carlo simulation technique to generate a pseudo-random sample statistical distribution for a user-defined output function. Each input variable exhibits random, statistical variations that are represented by a particular probability distribution (lognormal, normal, etc.). The statistical distribution for the output function (and accident scenario probability in this case) is generated by combining the distributions in accordance with the mathematical operations

specified by that function. This combining of distributions is accomplished as follows:

1. Each Monte Carlo sample consists of selecting one pseudo-random sample value for each input variable from its corresponding statistical distribution.

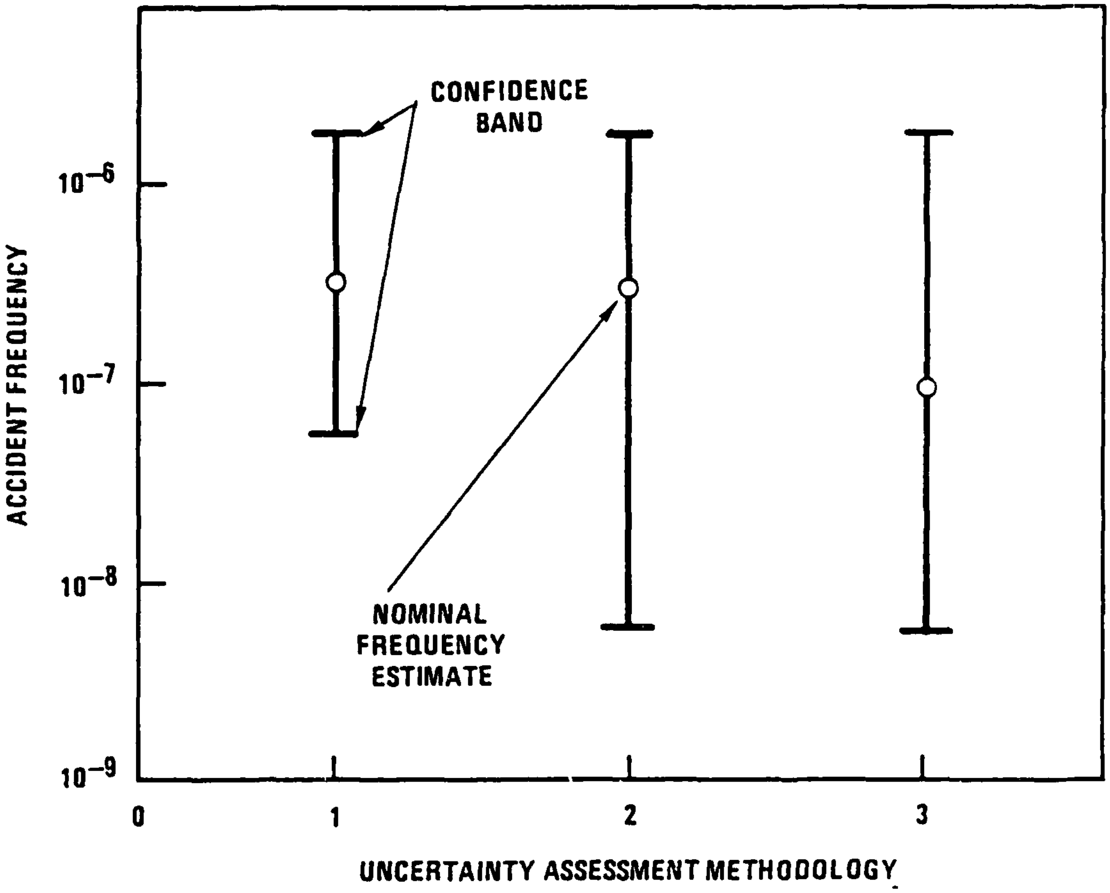
2. The set of sample variable values are mathematically combined to find the corresponding value of the function.

3. Sampling is continued in this manner until the desired sample size is attained.

4. The results consist of the pseudo-randomly generated values of the output function.

Probabilistic data base uncertainties are the only uncertainties explicitly quantified in this analysis. Although data base uncertainties are important, the accident frequency calculations are also sensitive to assumptions incorporated into the probabilistic assessment. Since the uncertainties in these assumptions are extremely difficult to quantify, conservative assumptions are consistently used in this risk analysis.

Figure 2-5 depicts the impact of this methodology (identified as Method 1 in the figure) on the accident frequency assessment results. Essentially, this methodology produces a conservative nominal frequency estimate, and underestimates the size of the confidence bands. However, the error associated with the confidence band estimate primarily results in predicting a much higher value for the lower confidence band than actually exists. (Compare the results of Methods 1 and 3 in Fig. 2-5.) Hence, the uncertainty assessment methodology employed in this analysis overestimates nominal accident frequencies and the confidence in the predicted frequency.



METHOD	DESCRIPTION
1	CONSERVATIVE ASSUMPTIONS, ONLY DATA BASE UNCERTAINTIES QUANTIFIED
2	CONSERVATIVE ASSUMPTIONS, ALL UNCERTAINTIES QUANTIFIED
3	REALISTIC ASSUMPTIONS, ALL UNCERTAINTIES QUANTIFIED

Fig. 2-5. Impact of assumptions on the accident frequency uncertainty assessment

No quantitative uncertainty analysis is performed for the agent release calculations, due to the complexity involved in such an assessment. Instead, conservative releases are calculated. Because of the complex phenomenology that governs agent release, sensitivity studies were conducted to assure that the agent release estimates are, indeed, bounding. These sensitivity analyses are presented in Appendix B.

2.7. REFERENCES

2-1. U.S. Nuclear Regulatory Commission, "PRA Procedures Guide," NUREG/CR-2300, 1982.

2-2. GA Technologies Report for Sandia National Laboratories, "High-Level Waste Preclosure Systems Safety Analysis Phase II Progress Report," GA-C18557, August 1986.

2-3. Fleming, K. N., "A Reliability Model for Common Mode Failures in Redundant Safety Systems," Procedures of the Sixth Annual Pittsburgh Conference on Modeling and Simulation, April 1975.

2-4. Swain, A. D., and H. E. Guttmann, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," NUREG/CR-1278, SAND 80-0200, August 1983.

2-5. Koch, P., and H. St. John, "STADIC-2, A Computer Program for Combining Probability Distribution," GA Report GA-A16777, July 1983.

3. DEMILITARIZATION DESCRIPTION OVERVIEW

Chemical munitions are currently stored at eight CONUS sites (Fig. 1-1). A description of the CONUS sites, including local maps, is given in Appendix D. Section 3.2 provides a summary description of the munitions.

A detailed discussion of the storage, handling operations, transport, and decommissioning activities related to the alternatives is presented in Appendix G. Section 3.1 provides a summary of these activities as they relate to the risk study. Data for the munition transport containers are presented in Section 3.3.

3.1. ONSITE DISPOSAL ACTIVITIES AND RISKS

The major activities for the onsite disposal option are outlined in Fig. 3-1. The activities begin with the munitions at each CONUS site in their existing storage locations in magazine igloos, warehouses or open areas. Long-term risks associated with continued storage, such as earthquakes and munition maintenance, are reduced by shipment to the disposal facilities. This risk reduction must be weighed against risks associated with the transfer and disposal of the munitions. Elements of the added risks are: added risks created by establishing holding areas and interim storage, handling operations, onsite transport, and disposal operations. These are discussed in the following paragraphs.

3.1.1. Storage

During storage, the only planned activities are monitoring for leakage, surveillance and maintenance, and repair of munitions. Internal events for storage thus address leakage between inspections and

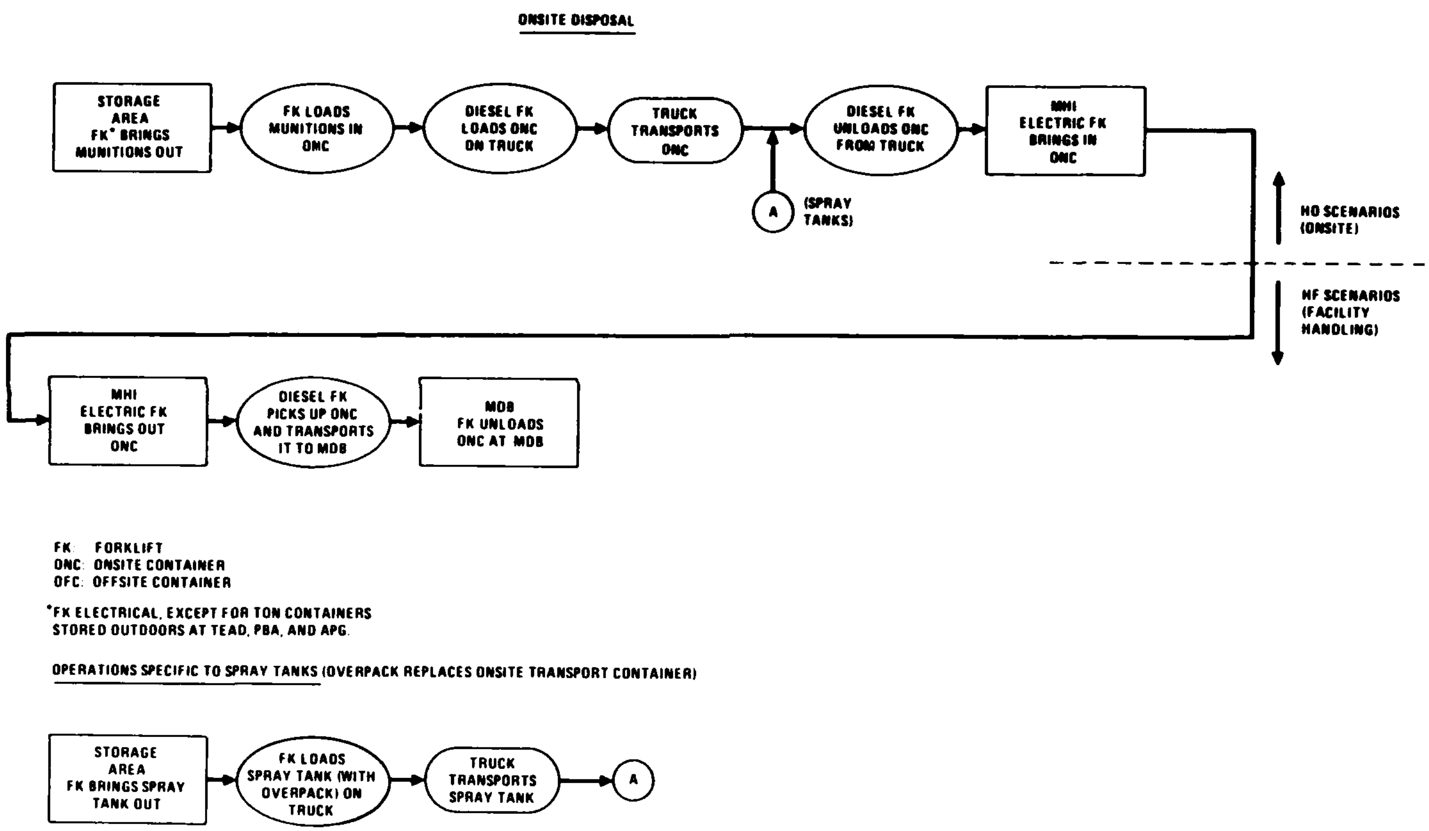


Fig. 3-1. Activities associated with onsite disposal

munition drop or forklift tine puncture during munition handling. The stored munitions are susceptible to external events, such as fire, tornado, aircraft or meteorite crash, earthquake flood, and lightning.

3.1.2. Handling

Basically, the risks associated with these handling operations stem from internal handling accidents, caused by equipment failures or human error. Types of accidents are: vehicle collisions, forklift tine punctures, and drops of munitions. The munitions affected may be single, in pallets or overpacks (bombs and spray tanks), or in an onsite container (ONC). Locations of the agent release may be indoors, or in the open (outdoors). Externally caused handling accidents were not considered in this analysis because of the short time involved in actual outdoor handling operations. Also, the analyses for plant operations and storage considers the effect of external events on all munitions within buildings or igloos, regardless of whether or not handling is in progress.

The handling risk depends on the number of handling operations, such as packing, loading, and separating, moving or stacking with a forklift, which in turn depends upon the sites involved, the mode of offsite transport, and the type of munition moved. Section 6 describes how these variables were factored into the analysis.

Packing handling operations occur first at the site storage area, where the munitions are packed inside an ONC for shipment to the MHI. This procedure results in the munition always being in the ONC while outdoors onsite.

Following onsite truck transport, the ONCs are unloaded at the MHI. The MHI is a part of the demilitarization facility. The packed munitions are stored on an interim basis in the MHI before they are moved to the package unloading facility within the MDB by forklift.

Loading and unloading handling operations occur at multiple times as follows:

1. At the site storage area, the ONCs are loaded into trucks for onsite transport.

2. At the MHI, the ONCs are unloaded from the trucks and later loaded onto diesel forklifts for transport to the MDB.

3. At the MDB, the forklifts deposit the ONCs in the UPA for final processing.

In this risk study forklift transport operations are assumed to belong to the handling phase while truck transport is not.

3.1.3. Onsite Transport

Onsite transport encompasses all truck transfer operations outlined above. Associated risks consist of truck collision and/or overturn accidents with the munitions configured in ONC packages (or spray tanks in overpacks). These risks depend upon the expected distance of truck travel.

At all sites the truck transfer distance from storage to the holding area is assumed to be one mile.

3.1.4. Plant Operations

The demilitarization activity involves all processes present in a JACADS-type demilitarization facility including removal and deactivation of explosives, draining and incineration of agent, and treatment of all process effluents and ventilation air. For this study, the demilitarization facility is defined to be the MHI, where munitions await processing, and the MDB, where the incineration occurs.

In the MDB the munitions are first unpacked in the package unloading facility. They are then transferred to the unpack area where they are processed by conveyor to the explosion containment room or munitions processing bay.

Risks associated with the plant operations (disposal) phase include internally (human error or equipment) caused accidents resulting in munition drops, spills, and fires or explosions in furnace rooms. Externally caused risks involve tornado, meteorite, aircraft crash, or earthquake induced events. The potential for such events to fail packaged munitions in the MHI or UPA, bare or disassembled munitions in the MDB, or process equipment was analyzed.

3.1.5. Decommissioning

After the existing stockpile of lethal chemical agent and munitions at each site has been destroyed, the demilitarization facility will be decommissioned. The activities for cleanup and closure of the destruction facilities, as discussed in Chemical Stockpile Disposal Plan (Ref. 3-1), are as follows:

1. Decontamination of the MDB and laboratory.
2. Disposal of all solid wastes and residues.
3. Certification of the plant and site as nontoxic.

An evaluation of risks associated with decommissioning is not a part of this study.

3.2. MUNITIONS DESCRIPTION

This section describes the munitions that comprise the CONUS munitions stockpile. The munitions stored at each site are summarized in Table 3-1. As indicated the inventory of munitions and bulk agent in storage differs greatly from site to site. Detailed information on the precise numbers of chemical agent munitions at each site is classified except for the information on M55 rockets. All of the chemical munitions in storage are at least 18 yr old (production of new chemical munitions was stopped in 1968), and some are more than 40 yr old.

The munitions stockpile consists of 11 different munition types. A detailed description of each munition type, including a discussion of their thresholds, is presented in Appendix F. A brief description of the munitions follows.

3.2.1. Rockets

The M55 rockets are filled with either GB or VX. The rockets are equipped with fuzes and bursters which contain explosives. Propellant is also built into the motor of the rocket. The rocket casing is made of aluminum. Some of the rockets have a leakage problem.

The rockets are individually packaged in fiberglass shipping tubes with metal end caps. Fifteen containers with rockets are packed on a wooded pallet.

3.2.2. Land Mines

Mines contain VX and explosive charges. The mines are packaged three to a steel drum. Mine activators and fuzes are packaged separately in the same drum. Twelve drums of mines are contained on a wooden pallet.

TABLE 3-1
DATA FOR ONSITE CONTAINERS (ONC)

<u>Size</u>

6-ft diameter by 8-ft long cylinder

<u>Failure Criteria</u>

Exposure to engulfing 1850°F detonates burstered munitions: 15 min

Exposure to engulfing 1850°F thermally fails munitions: 15 min

Impact failure: 40-ft drop (35 mph)

Puncture: Velocity/radius = 100 m/s

Crush: 50,000 lb static load

3.2.3. Projectiles and Mortars

The munitions stockpile contains 105-mm projectiles with GB or mustard, 155-mm projectiles with GB, VX, or mustard, 8-in. projectiles with GB or VX, and 4.2-in. mortar projectiles with mustard. Some 105-mm projectiles are stored as complete rounds containing fuze, burster with explosive, cartridge case and propellant, while others are stored without bursters, fuzes and propellant. Mortars are stored with fuzes, bursters, and propellants. The 155-mm and 8-in. projectiles are also stored with and without bursters.

The 105-mm projectiles are packed 24-projectiles to a pallet. The 4.2-in. mortar rounds are packed 48 to a pallet.

155-mm and 8-in. projectiles are packaged eight and six projectiles on a wooden pallet, respectively.

3.2.4. Bombs

There are three types of bombs, all containing GB agent. These are the MC-1, a 750-lb bomb, the MK-94, a 500-lb bomb, and the MK-116 ("weteye"), a 525-lb bomb. The 525-lb bomb is designed to release an aerosol spray of agent on detonation. The bombs are stored without explosives. The MC-1 bombs are packaged two to a wooden pallet and the others in individual metal shipping containers.

3.2.5. Spray Tanks

Spray tanks contain VX agent. They are designed for releasing chemical agent from slow-traveling, low-flying aircraft. The spray tanks are stored in a metal overpack container.

3.2.6. Bulk Agent

All three types of agent are stored in bulk as liquid in standard one-ton steel containers (called ton containers). Ton containers are not palletized.

Ton containers are the only items stored at the Aberdeen Proving Ground (APG) and Newport Army Ammunition Plant (NAAP). The ton containers at APG contain mustard (HD), while NAAP has VX-filled ton containers. ANAD has ton containers. PBA has mustard-filled ton containers. TEAD has all types of bulk agent in storage. UMDA has mustard-filled ton containers.

3.3. MUNITION PACKAGING AND TRANSPORT

Transport from the disposal site storage to the demilitarization facility is done with munitions in onsite containers (ONCs). The failure criteria for these containers are given in Table 3-1 (Ref. 3-1).

Leakers may be caused by the corrosive nature of the chemical agent on the materials in the munitions agent compartment wall. When leakers are detected in storage, the munitions are packaged in a special leak-proof package. No munitions known to be leaking are ever transported unless they are packaged in a special leak-proof package. Realistically, the major impact of corrosion is to degrade the original materials such that, while a leak has not occurred, the material parameters upon which the calculated failure thresholds are based generally do not reflect the actual condition of the munitions. The extent of degradation is unknown and cannot be considered in a meaningful way in the analyses presented in this report. Therefore, a general assumption is that the effect of corrosion or other material degradation is neglected, and a leak is assumed not to be initiated in transport. A leaking munition will not affect the public unless the transport package fails, but it is assumed that an accident must occur to produce package failure.

It is also assumed that when large fires (e.g., aircraft crash) occur, they engulf the entire transport vehicle. The assumption that the "representative" large fire always engulfs the transport vehicle is very conservative.

The structural calculations are based on the assumption that the munitions impact an unyielding surface, but because such surfaces are seldom encountered in real accidents, the structural failure thresholds are conservative.

The Sandia National Laboratory (SNL) transportation data base (refer to Sections 8 and 9) is assumed to be applicable to military transport. Where appropriate, modifications are clearly indicated to account for administrative controls. The major benefit of using the SNL transportation data base is that, in addition to providing accident rates for impact, fire, etc., the SNL researchers used sophisticated modeling to produce the accident environments that appear in the figures showing the percentage of accidents that do not exceed a certain force. These curves, or accident force spectra, are based on the best data available to SNL and a number of assumptions. The effect of administrative controls is to change either the data or the assumptions used to generate not only the accident rate but also the accident force spectra. Thus, a major assumption in this report is that when the accident rates are modified to account for factors unique to munitions aircraft, the accident force spectra are essentially unchanged. Use of the SNL curves is conservative, however.

No generally accepted method to quantify the probability of potential sabotage events in a risk analysis has been developed. Thus, any change in sabotage risk which occurs when extra packaging is used is not included in a quantitative way.

3.4. REFERENCES

3-1. Reed, A., et al., "Analysis of Existing Hazardous Material Containers for Transporting Chemical Munitions," The MITRE Corporation, June 1987.

4. INITIATING EVENTS

This section describes the approach used to identify and select initiating events and to assess their occurrence frequencies. As described in Section 2, initiating events are single occurrences or individual malfunctions that either directly cause the release of chemical agents or start a sequence of events that could lead to a release. They are classified as external events when caused by natural phenomena (e.g., earthquakes) or man-made interferences (e.g., aircraft crashes) from outside the demilitarization cycle. They are classified as internal when caused by human error or equipment failure within the demilitarization process. Section 4.1 describes the logic used for selection of the initiating events. Section 4.2 discusses the generic considerations in specifying the initiating event frequency units (i.e., per unit time or per operation). The application of these generic frequency estimates to specific accident scenarios, locations, and demilitarization phases are discussed in the sections dealing with accident logic model development, Sections 5 through 8.

4.1. INITIATING EVENT IDENTIFICATION AND SELECTION

This study used a multifaceted approach for identifying potential initiating events, screening out those which (based on conservative scoping) should not affect the overall risk, and selecting those events warranting further analysis. The approach consisted of:

1. Developing master logic diagram (MLD), a logic tool described in the PRA Procedures Guide (Ref. 4-1) for systematically examining potential modes of release, pathways for release, barriers against release, and mitigating safety functions together with root causes (initiators) of release.

2. Dividing the demilitarization facility (MDB) into spatial zones and examining potential sources of release in each zone to identify internal initiating events for plant operations.

3. Cross-referencing results from items 1 and 2 with a list of accident scenarios from safety related studies on the chemical weapons disposal program, compiled by the MITRE Corporation in Ref. 4-2.

4. Applying previous munitions risk study experience in Refs. 4-3 through 4-11 (the results of these studies are described in Section 1.1).

5. Peer review by the Army and independent consultants during the early and draft report phases of this study.

Two criteria were used to screen accident sequences: (1) accidents with extremely low frequency (below 10^{-10} per year) were eliminated from further analysis, and (2) those with low consequences (amount of agent release below 0.3 lb for GB, 14 lb for H, or 0.4 lb for VX) were also screened. Events with frequencies below the cutoff have little meaning from a practical standpoint, since the expected times between events is measured on a cosmic scale rather than on a scale of human history. The consequence criteria pertain to the minimum release levels that would produce acute human fatalities 0.5 km from the incident, based on environmental impact calculations performed by MITRE (Ref. 4-2).

For bookkeeping purposes, a coding system is used in this report to identify, organize, and refer to accident sequences. Not all accident sequences were encoded; those that could be screened out early because of simple conservative scoping analysis bear no coding. Conversely, many sequences that were screened after detailed analysis retain their coding but may not be in the final lists of results. However, Appendix A contains a record of all encoded sequences.

Table 4-1 shows the coding scheme followed for identification of accident sequences. The coding system is based on that used in Ref. 4-2. The first two letters identify the demilitarization phase (S for storage, H for handling, R for rail transport, V for truck transport, B for barge transport, L for LASH transport, and P for plant operations) and the offsite transport mode option or division of activities for that phase, if any. For example, VR, VA, and VW refer to onsite transport for rail, air, or marine options. The first two letters together with the sequence number at the end uniquely identify an accident sequence of events. The middle letters identify the munition/agent type combinations and the release mode. Throughout this report, either the entire coding is used or sequences are referred to by the first two letters and the sequence number.

The MLD developed for the risk study event identification is shown in Figs. 4-1 through 4-6. Following the PRA Procedures Guide (Ref. 4-1), the top-level logic (Fig. 4-1, level 1) pertains to the public impact, in this case, exposure to chemical releases throughout the various phases of the demilitarization process (storage, plant operations, handling, onsite transport and offsite transport).

Figure 4-2 shows MLD level 2 (release mode or pathway) and subsequent levels (barriers to release, safety functions mitigation/failure and, finally event initiators) for storage, including interim storage. It shows three modes for release. One is leakage of agent from corroded munitions, such as leakage of a ton container stored in open areas. Another is inadvertent rupture of a munition during maintenance. The third is a disruptive influence due to an external event. Since handling associated with incoming and outgoing munitions are considered in the handling phase, these three modes logically represent the possible ways a release can occur in the storage phase.

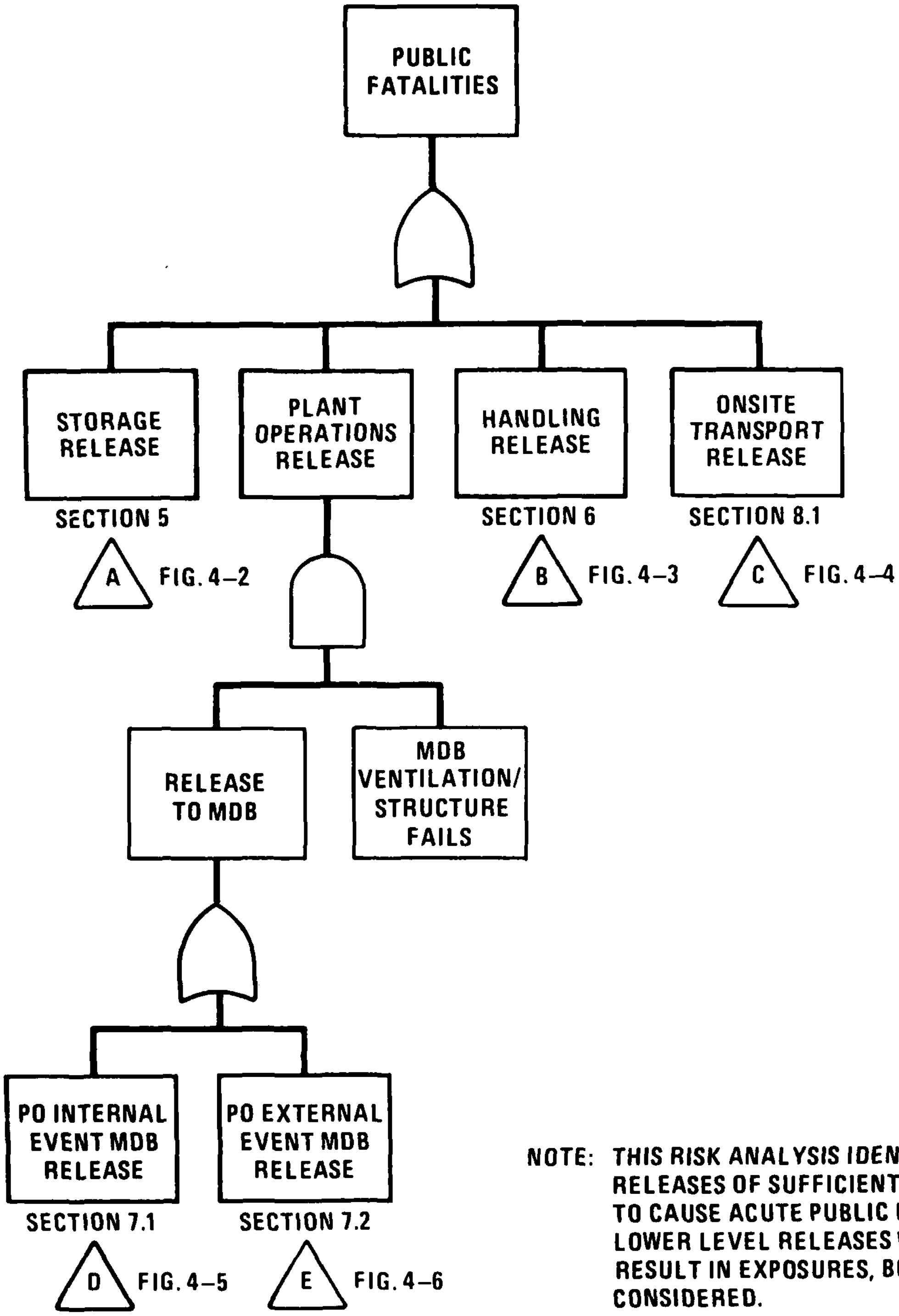
Subsequent levels are developed considering the types of disruptive events that can occur, taking into account information on the potential

TABLE 4-1
ACCIDENT SEQUENCE CODING SCHEME

The Accident Scenario Identification is an 8-Character Code for the Form: XXYZWnnn as Defined Below.

Activity (XX)	Rail	Air	Ship	Munition/Agent Type Combinations (YZ)
Plant operations	PO	PO	PO	BG: bomb containing GB
				BH: mortar containing H
Storage, long term	SL	SL	SL	CG: cartridge containing GB
				CH: cartridge containing H
Storage, interim	SR	SA	SW	KG: ton container with GB
				KH: ton container with H
Handling, at facility	HF	HF	HF	KV: ton container with VX
				MV: mine containing VX
Handling, onsite	HC	HA	HW	PG: projectile (155-mm) containing GB
				PH: projectile (155-mm) containing H
Truck transport	VO	VO	VO	PV: projectile (155-mm) containing VX
				QG: projectile (8-in.) containing GB

Release Mode (W)	Sequence No. (nnn)
S: Spill or leak	001, 002, 003, ... 999
C: Complex (e.g., detonation with fire)	
F: Fire only	



NOTE: THIS RISK ANALYSIS IDENTIFIES RELEASES OF SUFFICIENT MAGNITUDE TO CAUSE ACUTE PUBLIC FATALITIES. LOWER LEVEL RELEASES WOULD RESULT IN EXPOSURES, BUT ARE NOT CONSIDERED.

Fig. 4-1. Master logic diagram - level 1 (public impact)

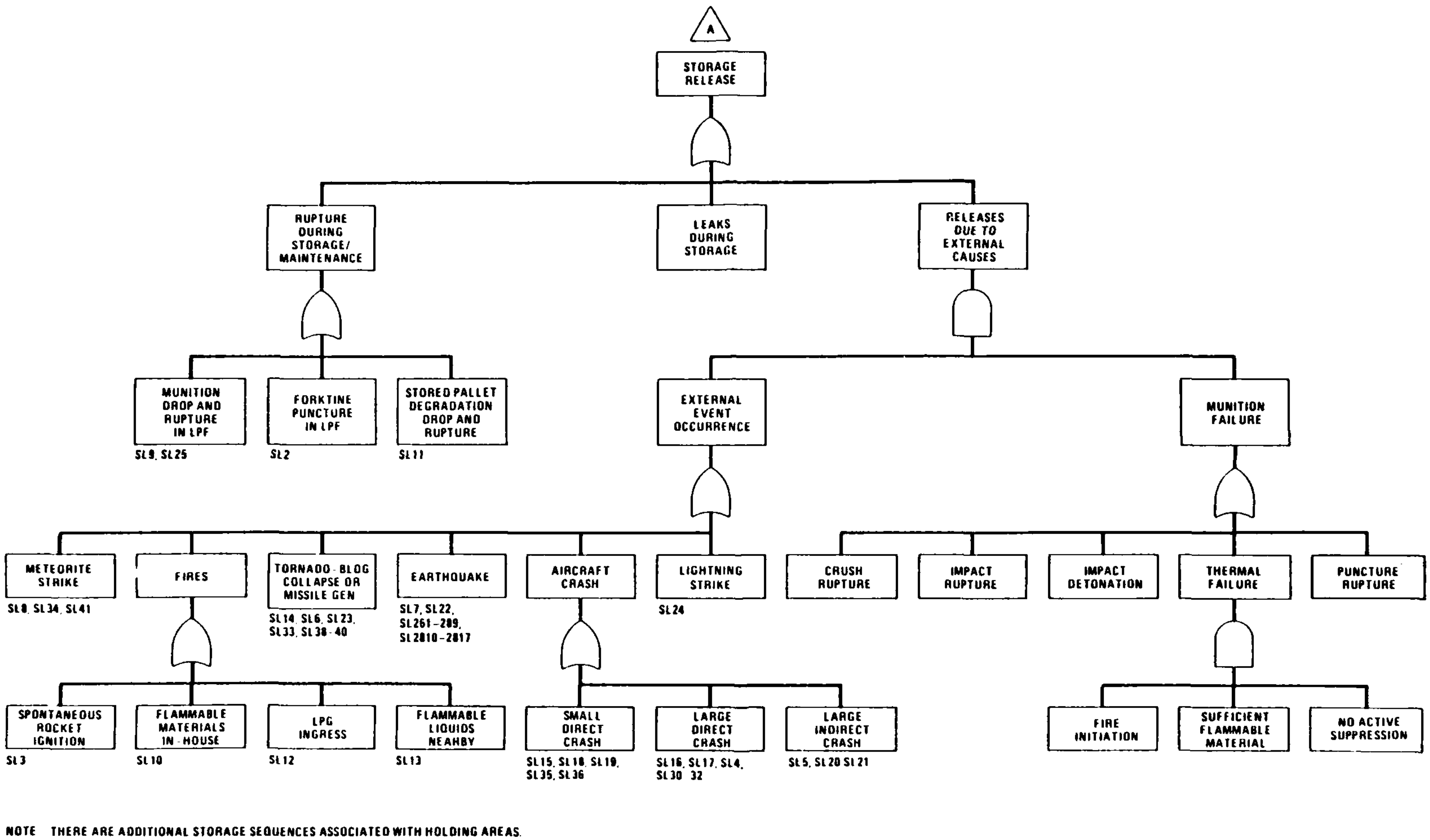


Fig. 4-2. Master logic diagram - levels 2 (release pathway) and lower (barriers, safety functions, and initiators). Part A - storage release

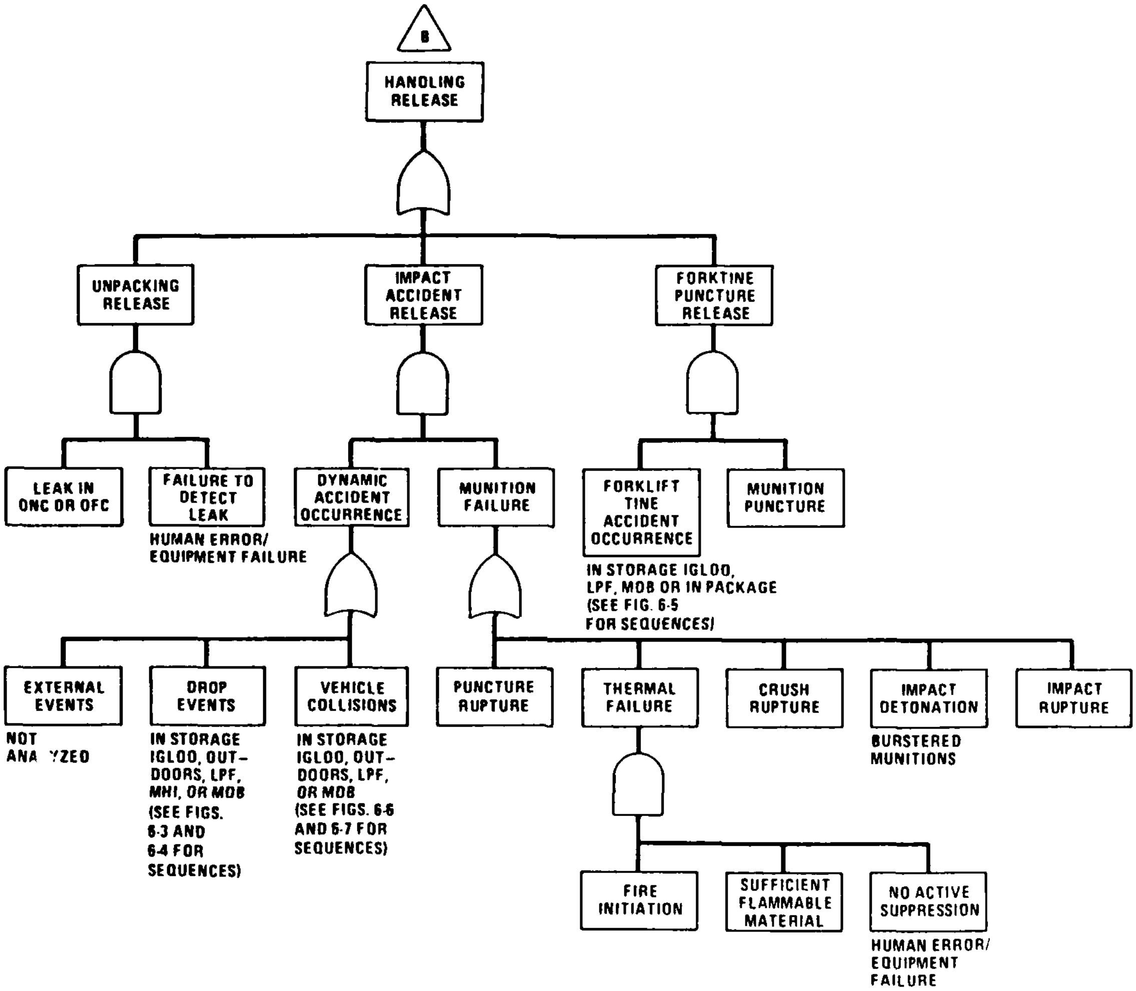


Fig. 4-3. Master logic diagram - levels 2 (release pathway) and lower (barriers, safety functions, and initiators). Part B - handling release

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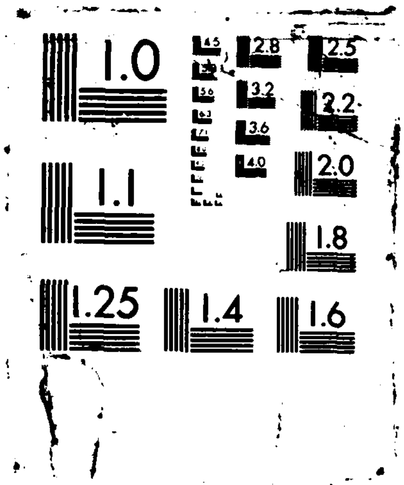
1.0
1.1
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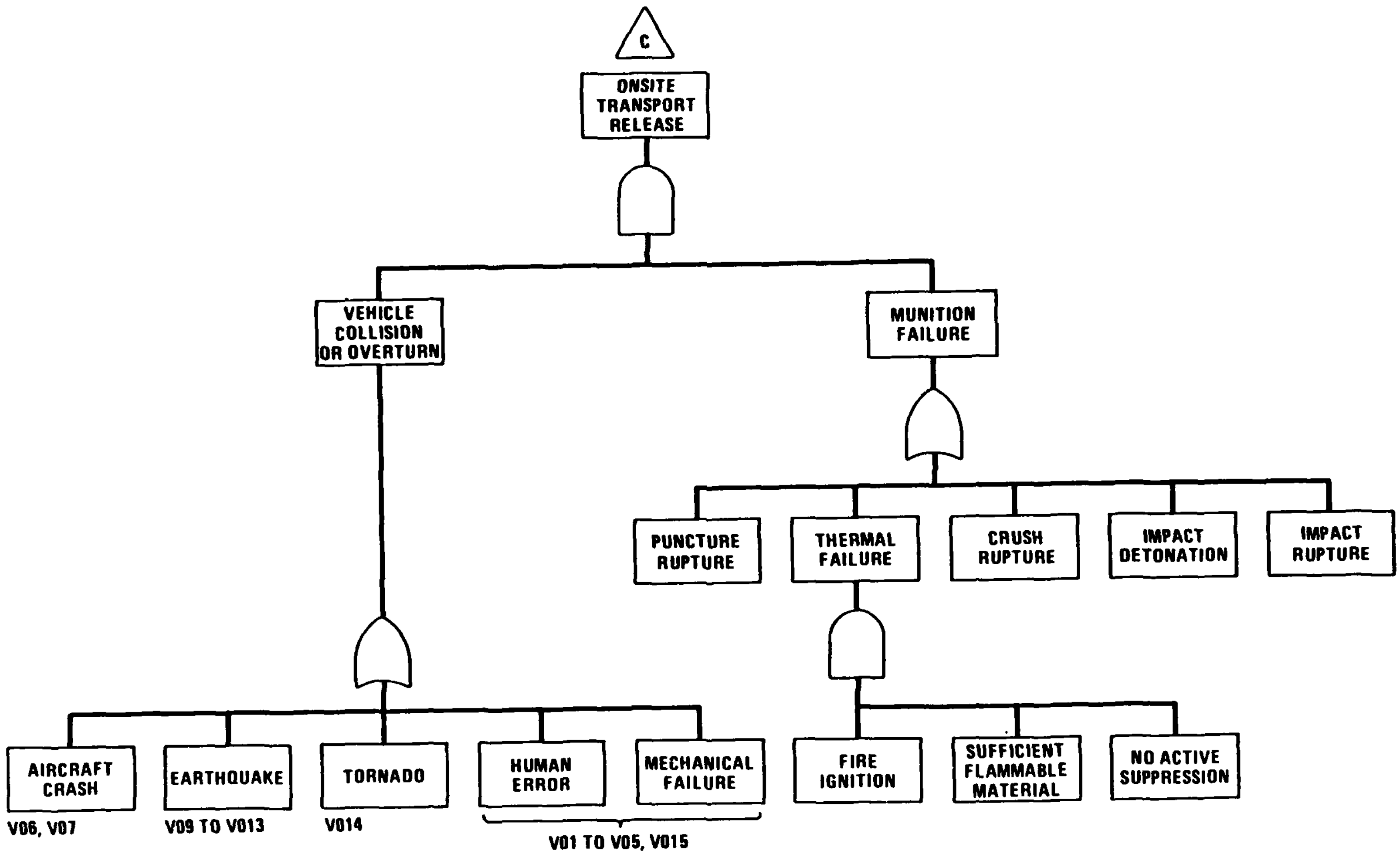

Fig. 4-4. Master logic diagram - levels 2 (release pathway) and lower (barriers, safety functions, and initiators). Part C - onsite transport release

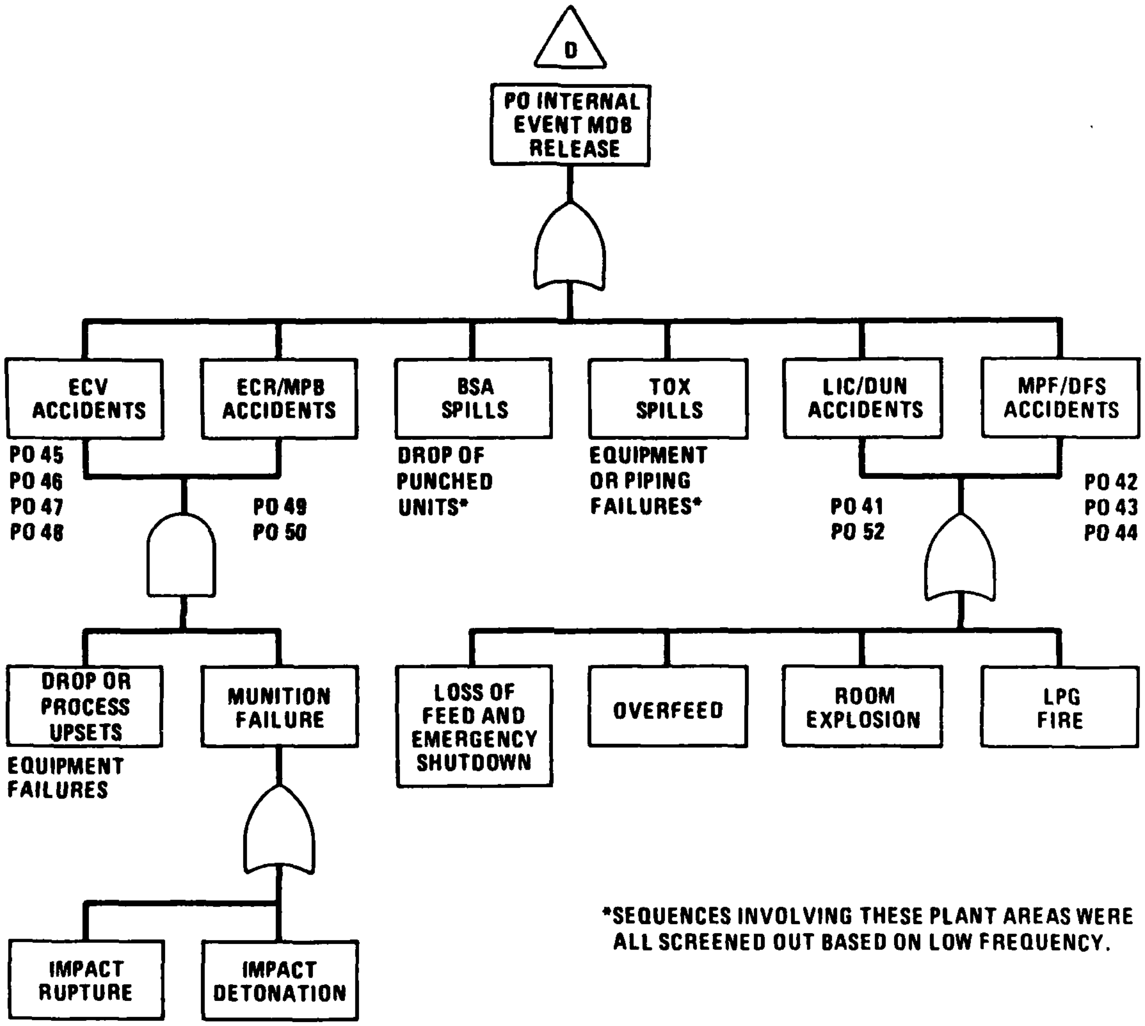

Fig. 4-5. Master logic diagram - levels 2 (release pathway) and lower (barriers, safety functions, and initiators). Part D - plant operations internal events

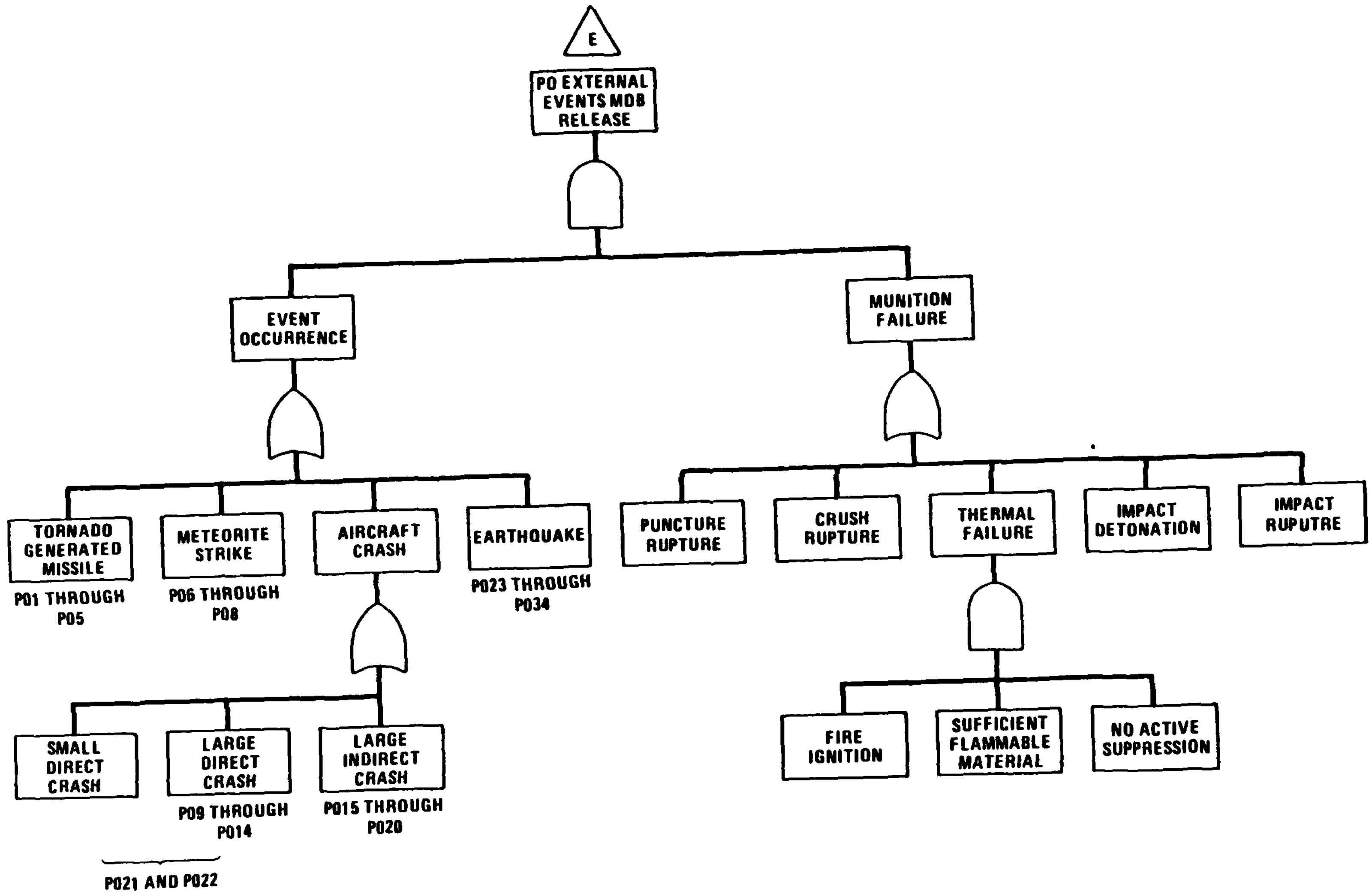

Fig. 4-6. Master logic diagram - levels 2 (release pathway) and lower (barriers, safety functions, and initiators). Part E - plant operations external events

failure modes of the munitions (puncture, detonation, fire, etc.), given that the event occurs. For illustration, some sequences analyzed in Section 5 are noted under the initiating event boxes. Table 4-2 summarizes the initiating event families for storage selected for analysis.

Figure 4-3 shows the MLD levels 2 and lower for handling operations. There are three modes of release: release due to unpacking of undetected leakers, impact rupture due to handling accidents (drops and forklift collisions), and forklift tine puncture. Note that external events are not included here; external events for storage and transport consider the entire munitions inventory available regardless of whether handling operations are in progress. The subsequent level initiating events consider the location where the event occurs, since different barriers for release are involved (e.g., if the event occurs indoors or in an open area). Table 4-3 summarizes the families or handling initiating events selected for analysis.

The MLD for onsite truck transport is developed in Fig. 4-4. A single generic mode of release applies to this phase, involving a vehicle collision or overturn coupled with potential munitions failure modes. In this phase, the munitions are always in onsite transport containers or overpacks, and failure thresholds may differ from those for bare munitions. Table 4-4 summarizes the initiating event families analyzed for onsite transport.

Figure 4-5 shows the MLD level 2 and subsequent levels for internal events during plant operations. This portion of the MLD was constructed by dividing the MDB into spatial zones and examining the sources for agent release in each zone. The zones are as follows:

1. The explosive containment vestibule (ECV) and munitions corridor.

TABLE 4-2
INITIATING EVENT FAMILIES FOR STORAGE

INTERNAL EVENTS

1. Munition drop
   a. During leaker isolation
   b. Due to pallet degradation

2. Forklift tine puncture during leaker isolation

3. Leak between inspections

EXTERNAL EVENTS[a]

1. Fires due to
   a. Spontaneous ignition of a rocket
   b. Flammable materials in an igloo or warehouse
   c. LPG ingress into an igloo or warehouse
   d. Flammable liquids near a warehouse at NAAP

2. Meteorite strikes an igloo, warehouse, or interim storage holding area

3. Tornado collapses a building or generates a missile

4. Aircraft crash due to
   a. Small aircraft (direct)
   b. Large aircraft (direct)
   c. Large aircraft (indirect)

5. Earthquake

6. Lightning strikes outdoor storage

[a]Note: Floods are shown in Section 5 to be unimportant initiators.

TABLE 4-3
INITIATING EVENT FAMILIES FOR HANDLING

1. Drop during operations at the processing facility of a

   a. Pallet or ONC outdoors
   b. Pallet or ONC in the MDB
   c. Single munition in the MDB

2. Drop during operations outside the facility of a

   a. Pallet or ONC in a storage igloo
   b. Pallet or ONC outdoors
   c. Pallet or ONC in the MHI
   d. Pallet in the LPF
   e. Single munition in the LPF

3. Forklift tine puncture of a

   a. Bare munition in a storage igloo
   b. Bare munition in the LPF
   c. Bare munition in the MDB
   d. ONC outside the facility
   e. ONC at the facility

4. Forklift collision at the processing facility for a

   a. ONC outdoors
   b. ONC in the MDB

5. Forklift or CHE collision outside the facility for a

   a. Palletized munition outdoors
   b. Palletized munition in a storage igloo
   c. Palletized munition in the LPF
   d. ONC outdoors
   e. ONC in an MHI

6. Failure to detect a leak in an ONC

TABLE 4-4
INITIATING EVENT FAMILIES FOR ONSITE TRUCK TRANSPORT

INTERNAL EVENTS

1. Truck collision or overturn due to human error or equipment failure
   a. With fire
   b. Without fire

EXTERNAL EVENTS

1. Aircraft crash into a truck
   a. With fire
   b. Without fire

2. Earthquake causes a truck collision or overturn
   a. With fire
   b. Without fire

3. Tornado causes a truck collision or overturn
   a. With fire
   b. Without fire

2. The munitions processing systems within the explosive containment room (ECR) and the munitions processing bay (MPB).

3. The buffer storage area (BSA), particularly punched and drained units present there.

4. The TOX tanks and associated piping systems.

5. The furnaces (MPF and DFS) and incinerators (LIC and DUN) and associated rooms.

For zones 1 and 2, the munitions present are unpunched. Thus, both a fall or other upset and a failure of the munition casing must occur for an agent spill. In zone 3, only the event is needed since the munitions are punched. Zone 4 refers to vessels and piping containing liquid agent; failure or rupture of safety grade metallic barriers are required for spills. Should spills occur in zones 1 through 4, they would drain to the appropriate sump. Evaporation from the floor and sump or a possible burning of the spill could result in a release to the environment if the MDB ventilation system or building structure fails. Zone 5 includes furnace and incinerator rooms where the release pathway is via accidental explosions.

Figure 4-6 shows the corresponding logic diagram for release due to external events during plant operations. Here, the conditional failure of the MDB structure may be more likely or certain, given the catastrophic nature of the external events, such as meteorite strike or aircraft crash. Table 4-5 summarizes the initiating event families for plant operations.

TABLE 4-5
INITIATING EVENT FAMILIES FOR PLANT OPERATIONS

INTERNAL EVENTS

1. Accident in the ECV fails a munition
2. Accident in the ECR or MPB fails a munition
3. Accident in the BSA causes a punched munition spill
4. Failure of TOX tank or piping causes a spill
5. Accident associated with a furnace or incinerator which releases agent vapor

EXTERNAL EVENTS

1. A tornado generated missile fails
   a. MHI munitions
   b. UPA munitions
   c. TOX/BDS piping (outdoor for CAMDS)
2. A meteorite fails
   a. MHI munitions
   b. UPA munitions
   c. TOX/BDS piping
   d. Agent collection tanks in TOX
3. A direct large aircraft crash fails
   a. MHI munitions
   b. UPA munitions
   c. TOX/BDS piping (outdoor for CAMDS)
   d. Agent collection tanks in TOX
4. An indirect large aircraft crash fails
   a. MHI munitions
   b. UPA munitions
   c. Agent collection tanks in TOX
5. A direct small aircraft crash fails TOX/BDS piping (outdoor for CAMDS)
6. An earthquake fails
   a. MHI munitions
   b. UPA munitions
   c. Agent collection tanks in TOX
7. A truck accident fails
   a. TOX/BDS piping (outdoor for CAMDS)

4.2. INITIATING EVENT FREQUENCIES

4.2.1. External Events

This section presents the site-specific frequencies of external initiating events considered in this study. Table 4-6 summarizes the results for occurrences at each of the eight CONUS sites. Table 4-7 presents the nonsite-specific occurrence frequencies. The bases for these results are discussed in the following subsections.

4.2.1.1. Earthquakes. The frequency at which a major earthquake occurs at a specific site varies significantly throughout the United States (Table 4-8). In an attempt to quantify the seismic risk associated with a particular site, the Seismology Committee of the Structural Engineers Association of California (SEAOC) has divided the United States into five seismic zones. Maps of these seismic zones are presented in the Uniform Building Code (Ref. 4-11) and in Army TM 5-809-10 (Ref. 4-12). Figure 4-7 presents the seismic zone map from TM 5-809-10, and Table 4-8 presents the seismic zones indicated for each of the storage sites. The probability of seismic damage in each of the zones is defined in Ref. 4-11 as follows:

Zone 0 - None	Zone 3 - Major
Zone 1 - Minor	Zone 4 - Great
Zone 2 - Moderate	

The determination of a seismic zone on a site is based on the history of past earthquakes and the proximity of known faults. Appendix D presents listings of the earthquakes that have occurred in the vicinity of each of the storage sites. The magnitudes of the earthquakes are expressed as Modified Mercalli Intensities (MMI). Table 4-8 presents a summary of the maximum earthquake occurring in the vicinity of each of the storage sites. The maximum earthquake recorded at any of the eight storage sites is an MMI VIII.

TABLE 4-6
SITE-SPECIFIC FREQUENCIES OF EXTERNAL INITIATING EVENTS

	APG	ANAD	LBAD	NAAP	PBA	PUDA	TEAD	UMDA
Large aircraft crash (events/yr-mi^2)	5.3×10^{-7}	7.9×10^{-6}	4.5×10^{-6}	4.6×10^{-6}	1.5×10^{-6}	5.9×10^{-5}	3.6×10^{-7}	1.5×10^{-5}
Small aircraft crash (events/yr-mi^2)	7.8×10^{-3}	1.2×10^{-5}	1.8×10^{-7}	2.3×10^{-5}	1.1×10^{-4}	1.0×10^{-4}	1.5×10^{-5}	1.2×10^{-5}
Meteorite (>1.0 lb) strikes (events/yr-ft^2)	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}	6.4×10^{-13}
Lightning (events/yr-mi^2)	7.8	23.3	23.3	12.9	28.5	10.4	7.8	5.2
Earthquakes (events/yr)								
- 0.15 g	1.5×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	7.5×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	4.0×10^{-3}	1.5×10^{-4}
- 0.2 g	7.0×10^{-5}	7.0×10^{-5}	7.0×10^{-5}	3.6×10^{-4}	7.0×10^{-5}	7.0×10^{-5}	2.0×10^{-3}	7.0×10^{-5}
- 0.25 g	4.0×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	2.3×10^{-4}	4.0×10^{-5}	4.0×10^{-5}	1.0×10^{-3}	4.0×10^{-5}
- 0.3 g	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	1.3×10^{-4}	2.5×10^{-5}	2.5×10^{-5}	7.0×10^{-4}	2.5×10^{-5}
- 0.4 g	1.2×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	5.0×10^{-5}	1.2×10^{-5}	1.2×10^{-5}	2.6×10^{-4}	1.2×10^{-5}
- 0.5 g	6.0×10^{-6}	6.0×10^{-6}	6.0×10^{-6}	2.0×10^{-5}	6.0×10^{-6}	6.0×10^{-6}	1.0×10^{-4}	6.0×10^{-6}
- 0.6 g	3.5×10^{-6}	3.5×10^{-6}	3.5×10^{-6}	1.0×10^{-5}	3.5×10^{-6}	3.5×10^{-6}	4.5×10^{-5}	3.5×10^{-6}
- 0.7 g	2.5×10^{-6}	2.5×10^{-6}	2.5×10^{-6}	7.0×10^{-6}	2.5×10^{-6}	2.5×10^{-6}	2.0×10^{-5}	2.5×10^{-6}
Tornadoes (events/yr)								
- 100 mph wind speed	---	---	---	---	---	---	1.0×10^{-5}	1.0×10^{-5}
- 140 mph wind speed	---	---	---	---	---	---	1.0×10^{-6}	1.0×10^{-6}
- 150 mph wind speed	1.0×10^{-5}	---	---	---	---	1.0×10^{-5}	---	---
- 180 mph wind speed	---	---	---	---	---	---	1.0×10^{-7}	1.0×10^{-7}
- 200 mph wind speed	1.0×10^{-6}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.0×10^{-6}	---	---
- 250 mph wind speed	1.0×10^{-7}	---	---	---	---	1.0×10^{-7}	---	---
- 260 mph wind speed	---	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	---	---	---
- 320 mph wind speed	---	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}	---	---	---

TABLE 4-7
EXTERNAL EVENT FREQUENCIES FOR SPECIAL CASES

Event	Frequency
1. Fires	
a. Spontaneous rocket ignition	(a)
b. Flammable material (inside)	(b)
c. LNPG ingress	(c)
d. Flammable liquids nearby	(d)
2. Marine transport events	
a. Heavy weather damage to lighters	3×10^{-9}/trip
b. Heavy weather damage to LASH	3×10^{-9}/trip
c. On-board fire (LASH)	3×10^{-9}/trip
3. Aircraft events	
a. On-board fire, C-141	7.6×10^{-9} accidents/flight-mile
b. On-board fire, C-5	3.2×10^{-8} accidents/flight-mile

[a] Negligibly low probability based on AMSAA report.

[b] Insufficient flammable material in storage areas; analyzed by plant area for the demil facility.

[c] Negligibly low rate of ingress relative to that needed for flammability.

[d] Applies only to NAAP; quantity of flammable material determined to be insufficient to threaten munitions.

TABLE 4-8
MAXIMUM MODIFIED MERCALLI INTENSITIES (MMI) IN THE VICINITY OF EACH SITE

Site	Seismic Zone	MMI	No. of Occurrences
Aberdeen Proving Ground (APG)	1	VII	1
Pine Bluff Arsenal (PBA)	1	VI	3
Pueblo Depot Activity (PUDA)	1	VI	1
Umatilla Depot Activity (UMDA)	1	VII	1
Anniston Army Depot (ANAD)	2	VII	1
Newport Army Ammunition Plant (NAAP)	2	VII	1
Lexington-Blue Grass Army Depot (LBAD)	2	VII	1
Tooele Army Depot (TEAD)	3	VIII	2

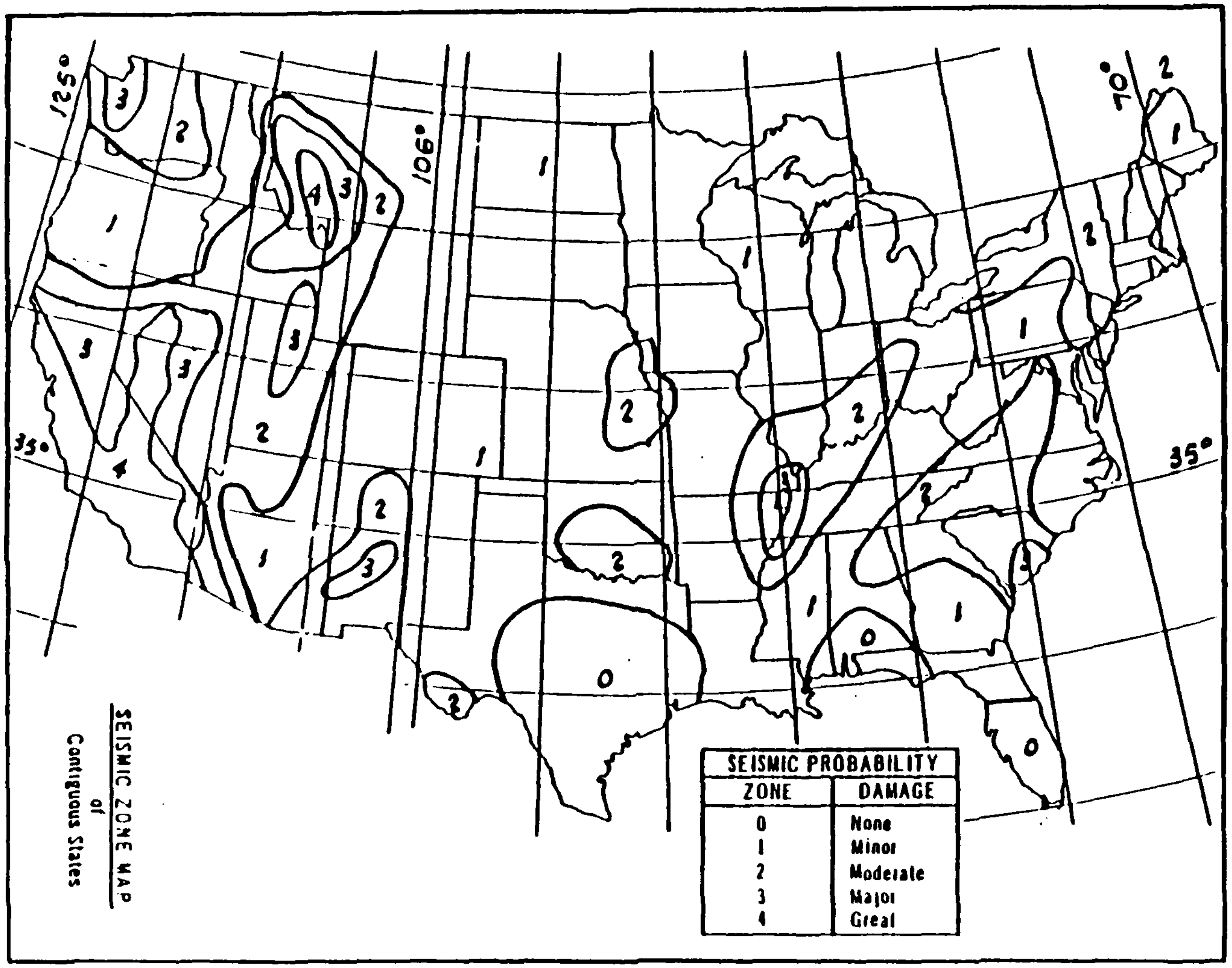

Fig. 4-7. Seismic zone map for the contiguous United States

Currently the Applied Technology Council, which is associated with the SEAOC, is developing new seismic regulations for buildings (Ref. 4-13). When this work is completed, it is expected to be the basis for future federal, state, and local building codes. Part of this work was the development of a seismic risk map that divides the United States into seven seismic map areas similar to the five seismic zones used in Refs. 4-11 and 4-12. The seismic risk is approximately constant throughout a seismic map area.

Figure 4-8 (from Ref. 4-13) presents a set of curves that can be used to estimate the probabilities of earthquakes of various g-levels occurring within a particular seismic map area. The dashed portions of the curves indicate possible extrapolations to larger and smaller annual probabilities.

Table 4-9 identifies the seismic map areas for each of the sites (Fig. 4-7) and tabulates the annual frequencies of earthquakes of various g-levels being exceeded at the storage sites. The data in Table 4-9 were obtained from Fig. 4-8. Straight line, logarithmic extrapolation was used to extrapolate to accelerations beyond the curves shown in Fig. 4-8. This method of extrapolation is believed to produce conservative estimates of the probabilities.

4.2.1.2. Wind Hazards. Methods for estimating the frequency and intensity of extreme winds can be found in ANSI/ANS-2.3-1983 (Ref. 4-14). The discussion which follows is largely based on the referenced national standard.

4.2.1.2.1. Tornadoes. A tornado is a violently rotating column of air whose circulation reaches the ground. The velocity of tornadic winds can exceed 300 mph. The path of a tornado can be more than a mile in width, but generally ranges from 0.125 to 0.75 mile wide. The path width is defined as the tornado diameter corresponding to a 75-mph wind velocity. The path of a tornado is seldom more than 10 miles long,

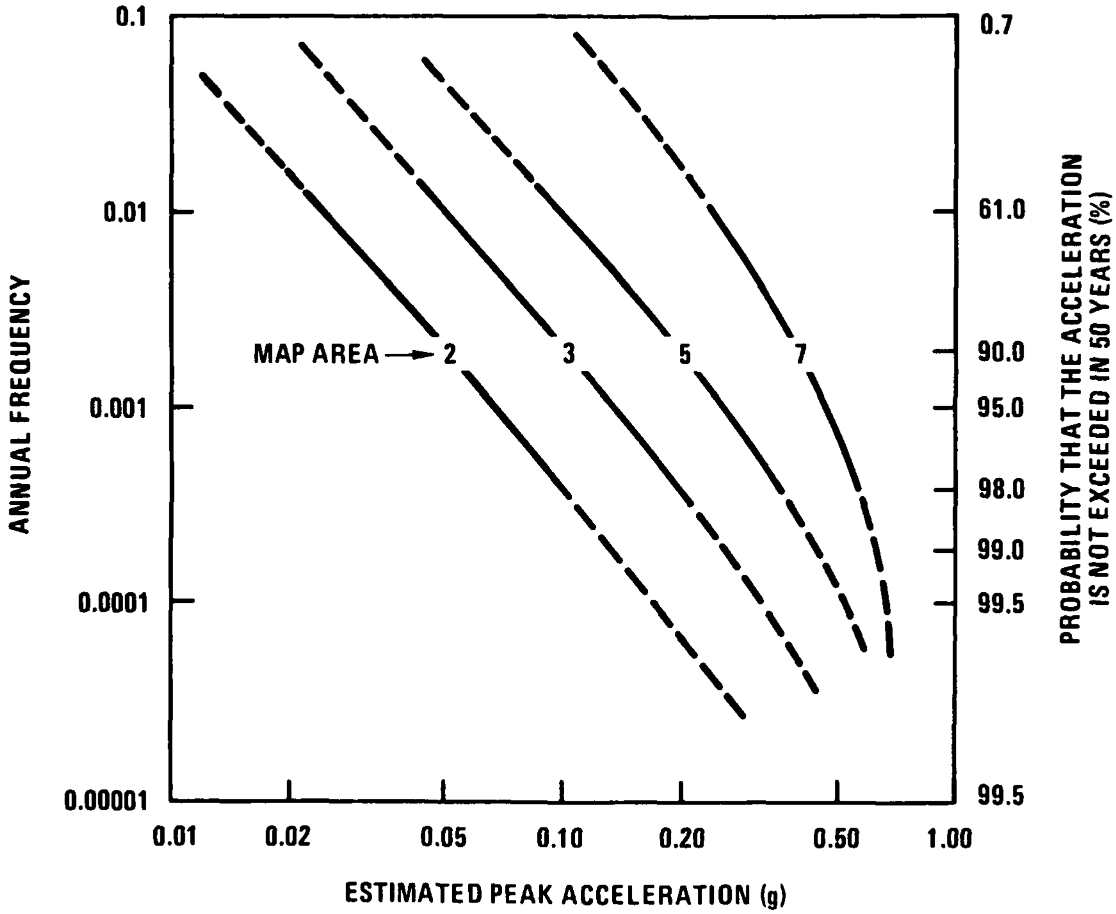

Fig. 4-8. Annual frequency of exceeding various effective peak accelerations for selected map areas defined by the Applied Technology Council (Ref. 4-13)

TABLE 4-9
ANNUAL RISK OF EARTHQUAKES

Site	Map Area	Acceleration (g-level)							
		0.15	0.20	0.25	0.3	0.4	0.5	0.6	0.7
TEAD	5	4.0E-3	2.0E-3	1.0E-3	7.0E-4	2.6E-4	1.0E-4	4.5E-5	2.0E-5
NAAP	3	7.5E-4	3.6E-4	2.3E-4	1.3E-4	5.0E-5	2.0E-5	1.0E-5	7.0E-6
APG, ANAD, LBAD, PBA, UMDA, PUDA	2	1.5E-4	7.0E-5	4.0E-5	2.5E-5	1.2E-5	6.0E-6	3.5E-6	2.5E-6

Data obtained from Fig. 4-8.

although extreme cases are on record where the storm path extended more than 200 miles.

Meteorological and topographic conditions, which vary significantly from site to site, influence the frequency of occurrence and intensity of tornadoes. Reference 4-14 presents three regionalized maps of tornadic wind speeds corresponding to return frequencies of 1.0×10^{-7}, 1.0×10^{-6}, and 1.0×10^{-5} per year. These maps (Figs. 4-9 through 4-11) are expected to bound the intensities and return probabilities at the various sites (Ref. 4-15). A tabulation of maximum tornado wind speed and return frequency for each of the storage sites based on these figures is presented in Table 4-10.

4.2.1.2.2. Tornado-Generated Missiles. One of the characteristics of a tornado is its capability to generate missiles from objects lying within the strike area and from nearby structural debris. The selection of tornado-generated missiles is dependent on the intensity of the tornado, the number of potential missiles present, their position relative to the tornado path, and the physical properties of the missiles. Reference 4-16 presents a spectrum of actual wind-generated missiles. Characteristics of these missiles are listed in Table 4-11, and expected windborne missile velocities are listed in Table 4-12.

4.2.1.2.3. Other Extreme Winds. The approach used for the determination of extreme wind speed (other than tornado) including hurricane winds is the method suggested by Science Applications International Corporation (SAIC). SAIC (Ref. 4-17) suggested the use of a basic wind speed as defined in Ref. 4-18. A frequency of occurrence of 2.0×10^{-2} per year is associated with a basic wind speed of 70 mph. SAIC concluded that the basic wind speed was applicable to all of the sites that store M55 rockets. Lacking site-specific meteorological data, it is assumed that the basic wind speed is applicable to the other sites as well.

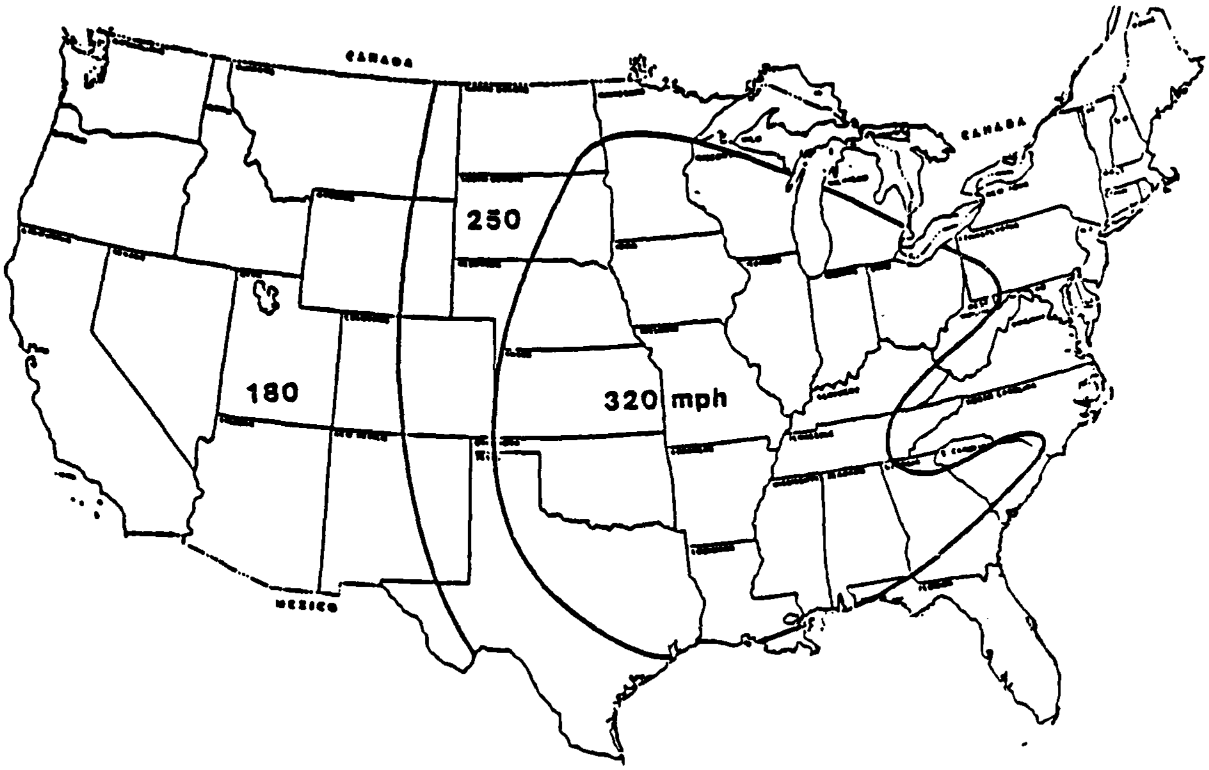

Fig. 4-9. Tornadic winds corresponding to a probability of 1.0E-7 per year

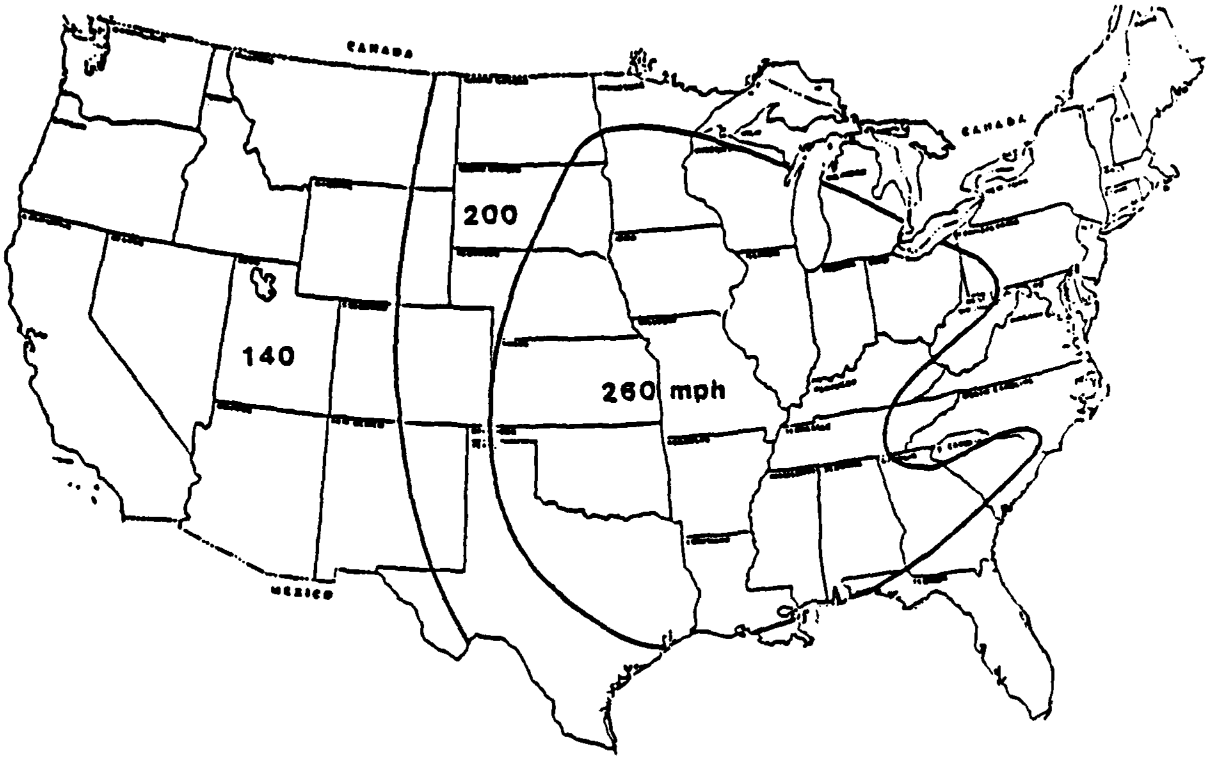

Fig. 4-10. Tornadic winds corresponding to a probability of 1.0E-6 per year

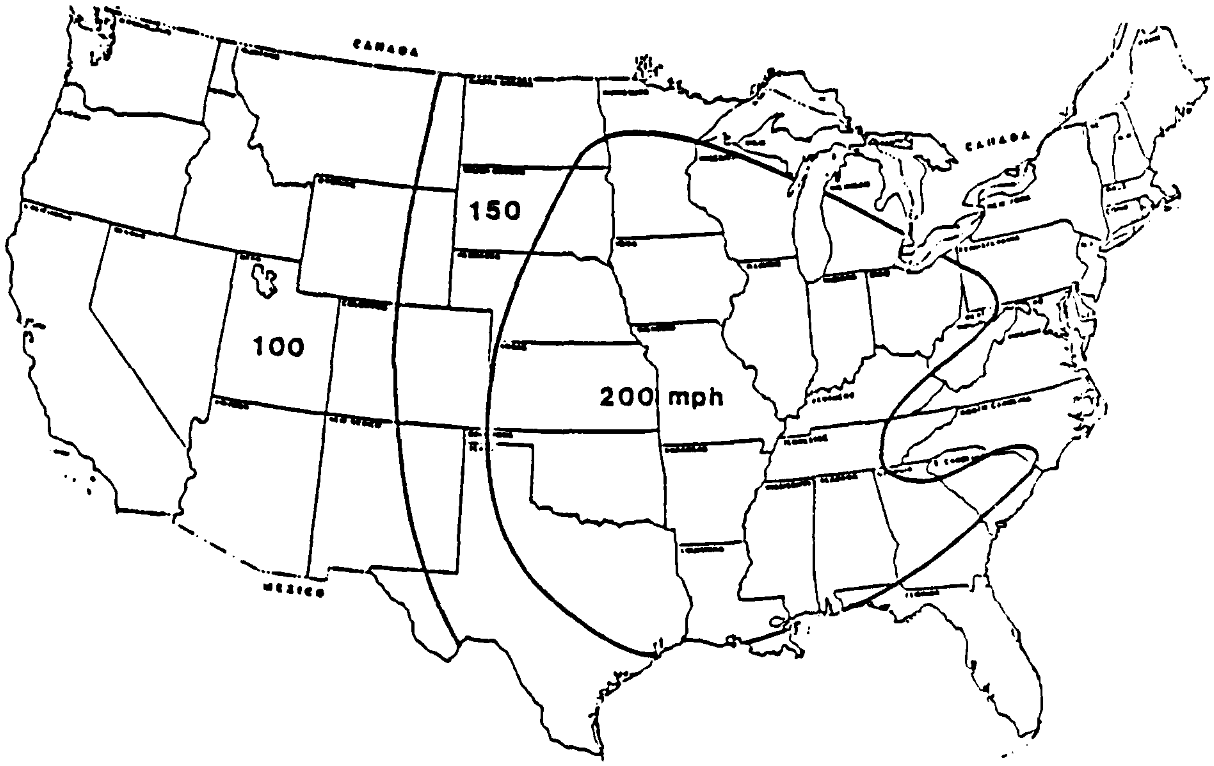

Fig. 4-11. Tornadic winds corresponding to a probability of 1.0E-5 per year

TABLE 4-10
TORNADO WIND SPEEDS AND PROBABILITY OF RECURRENCE
FOR CHEMICAL STORAGE SITES

	Probability of Occurrence Per Year [Wind Speed (mph)]		
Size	1.0E-5	1.0E-6	1.0E-7
ANAD (Anniston, Ala.)	200	260	320
LBAD (Lexington, Ky.)	200	260	320
UMDA (Umatilla, Oreg.)	100	140	180
PBA (Pine Bluff, Ark.)	200	260	320
TEAD (Tooele, Utah)	100	140	180
PUDA (Pueblo, Colo.)	150	200	250
NAAP (Newport, Ind.)	200	260	320
APG (Aberdeen, Md.)	150	200	250

TABLE 4-11
WIND-GENERATED MISSILE PARAMETERS[a]

Missile	Weight (lb)	Projected Area (ft^2)	Cross-Sectional Area (ft^2)
Timber plank 4 in. x 12 in. x 12 ft	139	11.50	0.29
Three-in.-diameter standard steel pipe x 10 ft	75.8	2.29	0.0155[b]
Utility pole 13.5-in.-diameter x 35 ft	1490	39.4	0.99
Automobile	4000	100.0	20.0

[a]Source: Ref. 4-16.

[b]Value given is metal area. In penetration calculations the gross cross-sectional area may be used.

TABLE 4-12
WINDBORNE MISSILE VELOCITIES[a]

Design Wind Speed	Horizontal Missile Velocity[b] (mph) 100	150	200	250	300	350	Maximum Height (ft)
Timber plank	60	72	90	100	125	175	200
Three-in.-diameter standard pipe	40	50	65	85	110	140	100
Utility pole	(c)	(c)	(c)	80	100	130	30
Automobile	(c)	(c)	(c)	25	45	70	30

[a] Source: Ref. 4-16.

[b] Vertical velocities are taken as two-thirds the horizontal missile velocity. Horizontal and vertical velocities should not be combined vectorially.

[c] Missile will not be picked up or sustained by the wind; however, for this analysis, any initial missile velocity of 80 mph or less was assigned a wind velocity of 250 mph.

In order to estimate the frequency of recurrence of winds of velocity greater than the basic wind speed, but less than the tornado wind speed, the following approach was taken. The tornado strength and frequency data, and the basic wind strength and frequency data were plotted on a scale of log probability versus wind strength. The results are shown in Figs. 4-12 through 4-14 for the three tornado regions of the United States as given in Ref. 4-14. A conservative approach to interpolating between the available data points is the bilinear approximation shown by the solid lines in the figures. With these figures, the probability of a given wind velocity occurring at any of the chemical storage sites can be estimated.

4.2.1.3. Aircraft Operations. Much of the data in this section were taken from the SAIC report (Ref. 1-9).

There are three major concerns in assessing potential hazards due to aircraft operations:

1. Proximity of aircraft operations to munitions areas.
2. The frequency of aircraft flights.
3. The characteristics of the aircraft traffic.

The proximity of aircraft operations to munitions activities is an important consideration in that approximately 50% of aircraft accidents which result in fatalities or destroy aircraft occur within 5 miles of airports (Ref. 1-9). Also, the close proximity of flight paths to munitions activities increases the likelihood of these areas receiving falling debris from aircraft accidents. The frequency of flight activity increases the possibility of damage to munitions by increasing the overall likelihood of an aircraft accident.

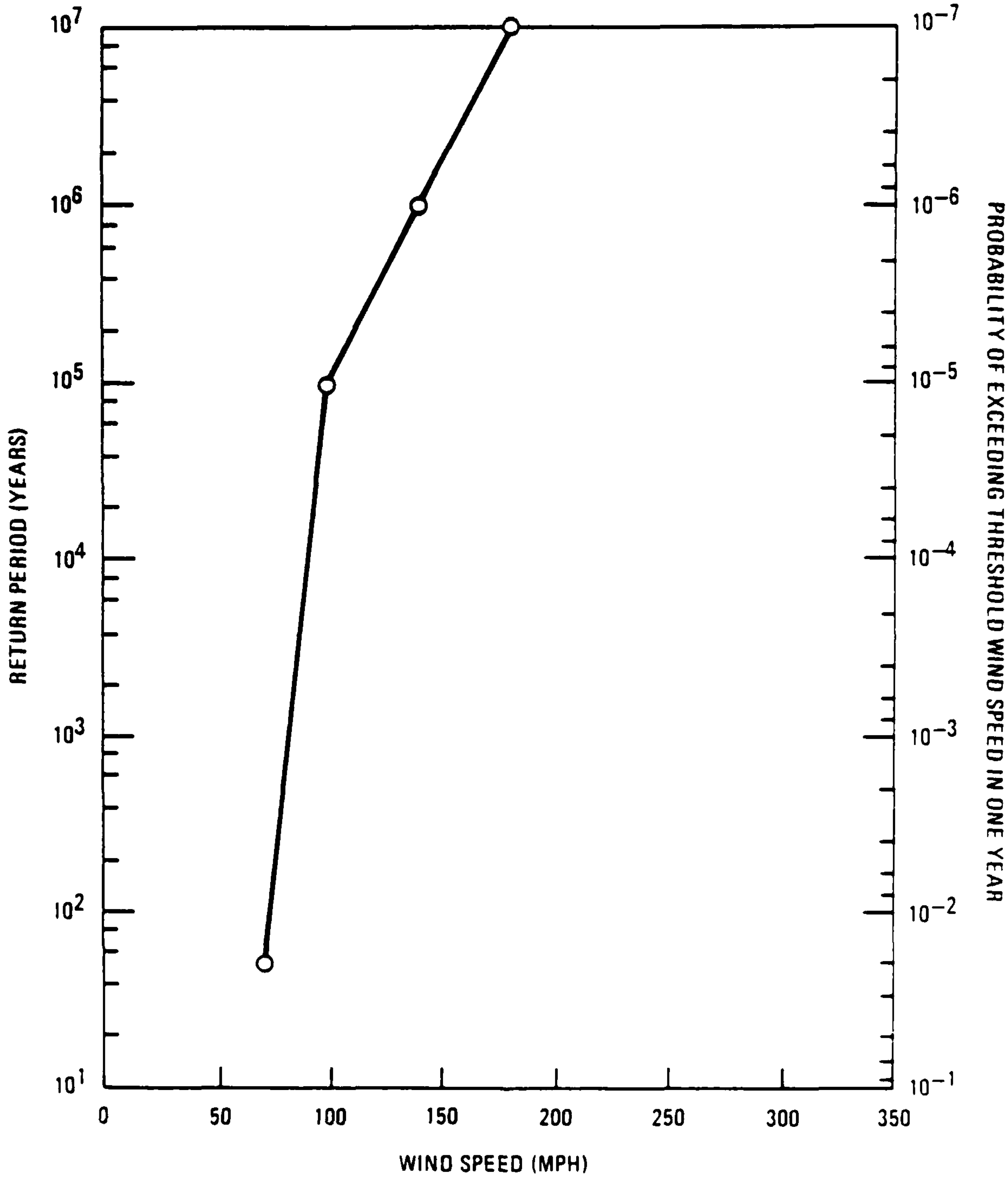

Fig. 4-12. Wind strength versus probability of recurrence, tornado Zone I (TEAD and UMDA sites)

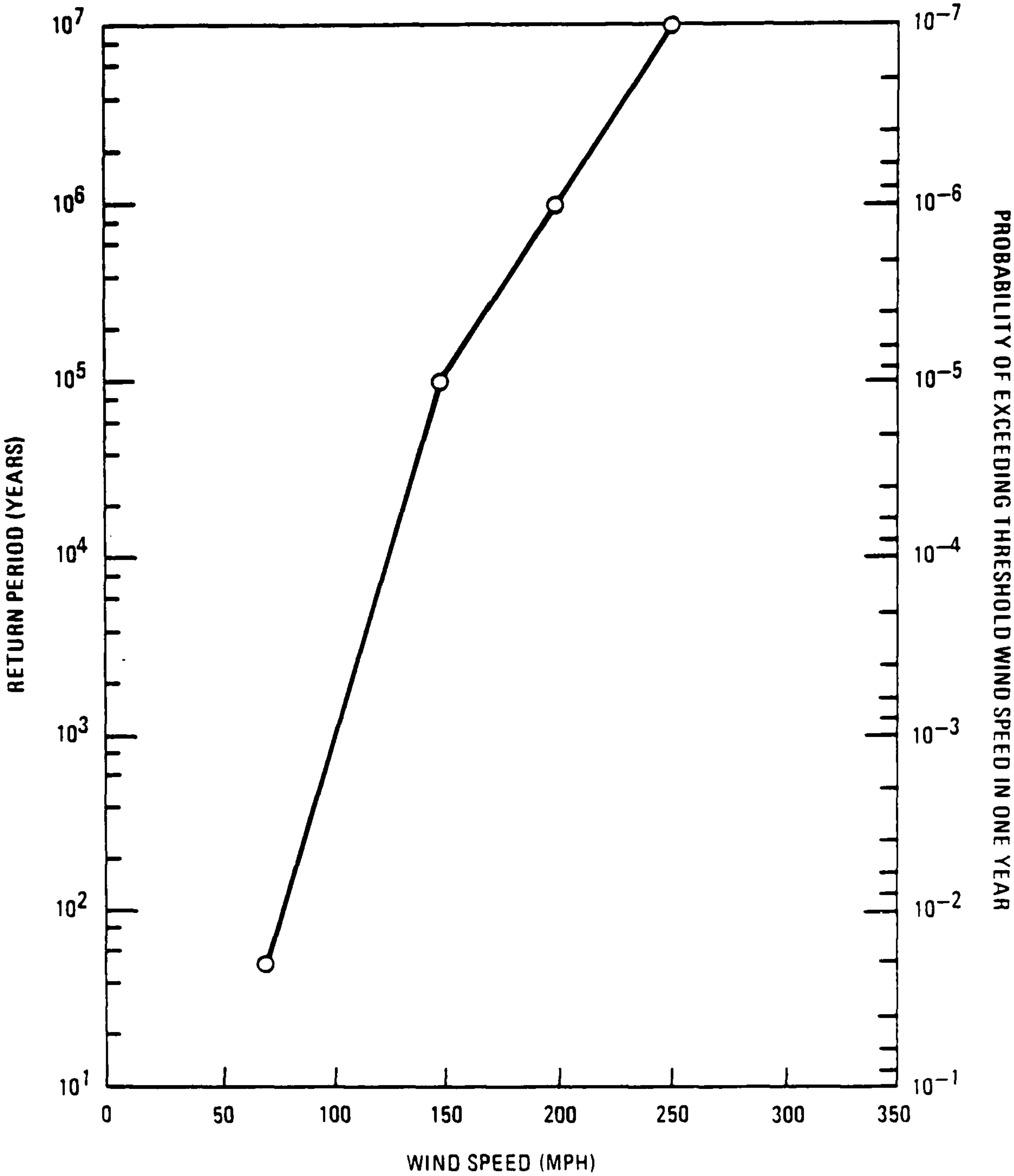

Fig. 4-13. Wind strength versus probability of recurrence, tornado Zone II (PUDA and APG sites)

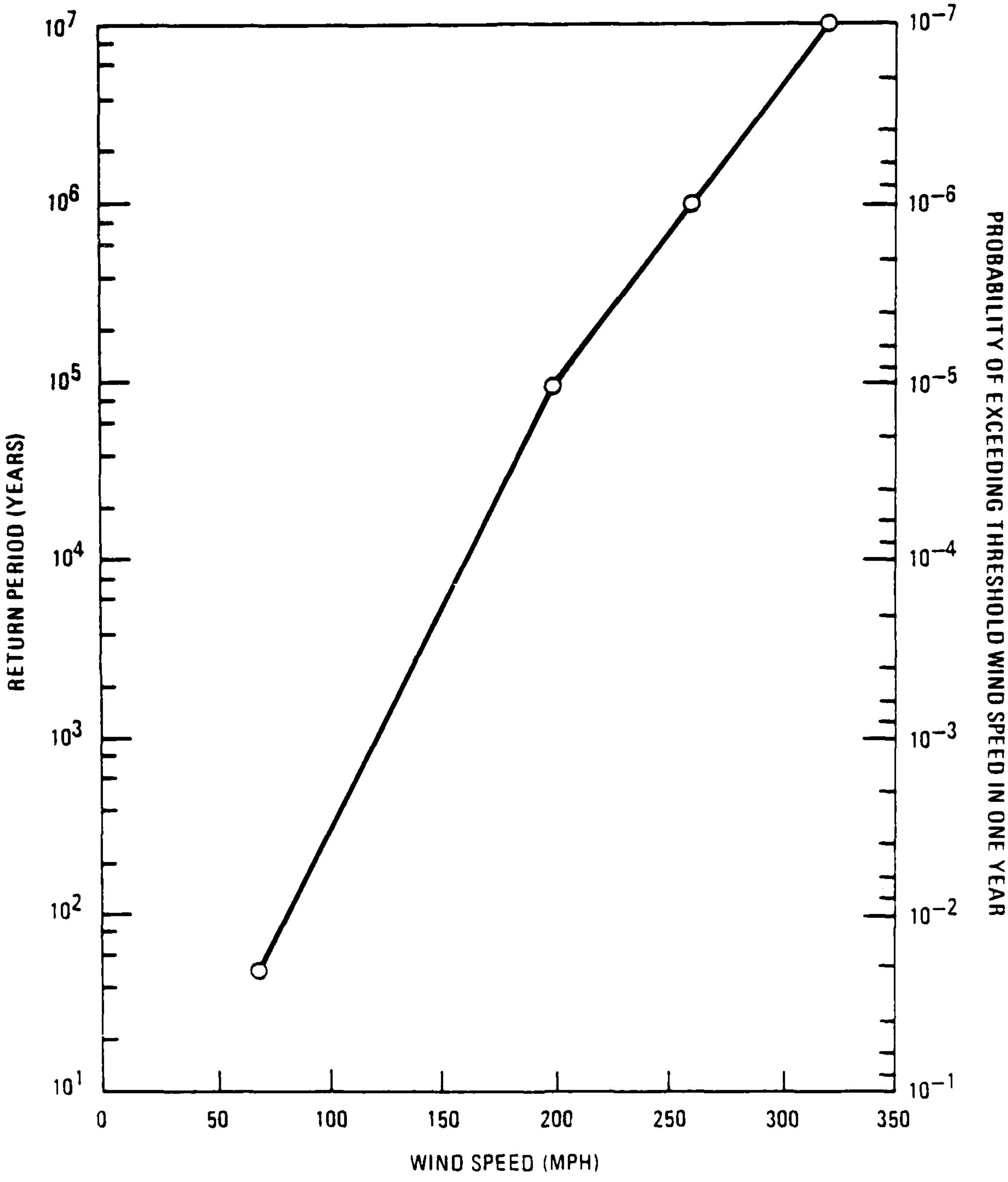

Fig. 4-14. Wind strength versus probability of recurrence, tornado Zone III (ANAD, LBAD, PGA, and NAAP sites)

Per the recommendations of NUREG-0800 (Ref. 19), the probability of an aircraft crash can be considered small if the distance to the site meets the following requirements:

1. The plant-to-airport distance (D) is between 5 and 10 statute miles, and the projected annual number of operations is less than 500 D^2, or the plant-to-airport distance is greater than 10 statute miles, and the projected annual number of operations is less than 1000 D^2.

2. The plant is at least 5 statute miles from the edge of military training routes, including low-level training routes, except those associated with a usage greater than 1000 flights per year, or where activities may create an unusual stress situation.

3. The plant is at least 2 statute miles beyond the nearest edge of a federal airway, holding pattern, or approach pattern.

The characteristics of an aircraft, such as its weight, number of engines, etc., are important in determining the energy of potential missiles generated in an aircraft accident, and depending on the structure they hit, the magnitude of the damage they may cause.

The frequency of an aircraft crashing while in an airway can be computed as follows (Ref. 4-19):

$$P_{FA} = C \times N \times A/W \quad , \qquad (4\text{-}1)$$

where C = inflight crash rate per mile for aircraft using airway,

W = width of airway (plus twice the distance from the airway edge to the site when the site is outside the airway) in miles,

A = effective area of facility in square miles,

N = number of flights per year along the airway.

For commercial aircraft, a value for C of 1.0×10^{-10} has been used (Ref. 4-19). For military aircraft, C is estimated to be five times the value for commercial flights (Ref. 4-13). For general aviation, C was estimated to be the same as for military aircraft.

The frequency of an aircraft crashing in the vicinity of an airport or heliport can be computed as follows (Ref. 4-19):

$$P_A = \sum_{j=1}^{L} \sum_{j=1}^{M} C_j \, N_{ij} \, A_j \quad , \qquad (4\text{-}2)$$

where L = number of flight trajectories affecting the target,

M = number of different flights using the airport,

C_j = probability per square mile of a crash per aircraft movement for j^{th} aircraft,

N_{ij} = number per year of movements by the j^{th} aircraft,

A_j = effective target area in square miles for the j^{th} aircraft.

The values for C_j which were used in the analysis are listed in Table 4-13. The total crash probability is the sum of P_{FA} and P_A. The methodology for selecting these values is discussed in Appendix C.

The Federal Aviation Administration (FAA) does not monitor the number of certain types of aircraft which fly the high and low altitude airways. Consequently, the air traffic was estimated. Since air traffic is not the same on all airways, the airways are divided into five categories with regard to air traffic: very low, low, medium, high, and very high. Table 4-14 presents estimates of the air traffic on each of these airways. Each airway was assigned to one of these categories based on the traffic expected between the cities that the airway connects. If there are no low altitude airways near a site, it is assumed that the air traffic over the site is at least equal to that for a very low air traffic airway.

TABLE 4-13
AIRCRAFT CRASH PROBABILITIES NEAR AIRPORTS

Distance From End of Runway	Probability (x 10^8) of a Fatal Crash per Square Mile per Aircraft Movement			
	Commercial	General Aviation	Military	Helicopters
0-1	16.7	84	7.0	168
1-2	4.0	15	1.7	30
2-3	0.96	6.2	0.72	12
3-4	0.68	3.8	0.37	7.6
4-5	0.27	1.2	0.30	2.4
5-6	0.14	0.70	0.14	1.4
6-7	0.14	0.70	0.14	1.4
7-8	0.14	0.70	0.14	1.4
8-9	0.14	0.70	0.14	1.4
9-10	0.12	0.60	0.12	1.2

TABLE 4-14
ASSUMED DISTRIBUTION OF AIR TRAFFIC[a]

Aircraft	Very Low	Low	Medium	High	Very High
High Altitude Jet Routes					
Large commercial	1,000	2,000	5,000	10,000	20,000
Large military	500	1,000	2,500	5,000	10,000
Large general aviation	500	1,000	2,500	5,000	10,000
Total	2,000	4,000	10,000	20,000	40,000
Low Altitude Airways					
Large commercial	400	800	2,000	4,000	8,000
Large military	240	480	1,200	2,400	4,800
Large general aviation	400	800	2,000	4,000	8,000
Small general aviation	6,960	13,920	34,800	69,600	139,200
Total	8,000	16,000	40,000	80,000	160,000

(a)Flights per year.

(b)The number of small commercial and small military flights is assumed to be small compared to other types of flights.

Appendix C presents tables which summarize the input data that were used to calculate the annual frequencies of both small and large aircraft crashes at each of the eight sites. The frequencies were computed using the equations given above. The annual frequencies for all the sites and for large and small aircraft and helicopters are summarized in Table 4-15.

A major source of air crashes is the proximity of airports and heliports. This is of particular concern at APG, PBA, and PUDA. The air traffic for the APG analysis was supplied by PEO-PM Cml Demil (Ref. 4-14). The helicopter air traffic at PBA was estimated by SAIC (Ref. 4-13). The air traffic at PUDA was based on data collected at Pueblo Memorial Airport and communicated to GA by telephone. The helicopter traffic at TEAD is light and was assumed to be 15 flights per month.

The annual frequency of a crash into a specific facility is computed by multiplying the appropriate frequency taken from Table 4-15 by the effective target area of the facility (see Appendix C).

4.2.1.4. Meteorites. The frequency of meteorite strikes for meteorites 1.0 lb or greater is $4.3 \times 10^{-13}/ft^2$ (Ref. 4-20). For small meteorites (a ton or less), stone meteorites are approximately ten times more common than iron meteorites (Ref. 4-21). However, iron meteorites are more dense and tend to have higher impact velocities, and consequently, represent a significant portion of the total meteorites that can rupture munitions. Table 4-16 shows the size distribution of striking meteorites for both iron and stone meteorites. The table was compiled from the data presented in Refs. 4-20 and 4-21.

4.2.2. Electromagnetic Radiation

Electromagnetic (E-M) radiation, either as a continuous source of energy or a short duration but higher energy pulse (EMP), has been considered as a potential hazard for control systems, sensitive explosive

TABLE 4-15
SUMMARY OF AIRCRAFT CRASH PROBABILITIES
(Crashes/Square-Mile/Year)

Site	Large Aircraft	Small Aircraft	Helicopters
<u>Rail and Marine Options</u>			
APG	5.3×10^{-7}	1.1×10^{-3}	6.7×10^{-3}
ANAD	7.9×10^{-6}	1.2×10^{-5}	N/A[(a)]
LBAD	4.5×10^{-6}	1.8×10^{-7}	N/A
NAAP	4.6×10^{-6}	2.3×10^{-5}	N/A
PBA	1.5×10^{-6}	1.8×10^{-7}	1.1×10^{-4}
PUDA	5.9×10^{-5}	1.0×10^{-4}	N/A
TEAD	3.6×10^{-7}	3.5×10^{-6}	1.1×10^{-5}
UMDA	1.5×10^{-5}	1.2×10^{-5}	N/A
<u>Air Option</u>			
APG	5.6×10^{-6}	1.1×10^{-3}	6.7×10^{-3}
LBAD	3.0×10^{-5}	1.8×10^{-7}	N/A
TEAD	3.1×10^{-5}	3.5×10^{-6}	1.1×10^{-5}

(a) N/A = not applicable.

TABLE 4-16
SIZE DISTRIBUTION OF METEORITES WHICH ARE 1.0 lb OR LARGER[a]

Weight Greater Than (lb)	Stone Meteorites[b]	Iron Meteorites[b]	All Meteorites[b]
1	0.9	0.1	1.0
2	0.3	3×10^{-2}	0.3
20	0.1	1×10^{-2}	0.1
200	3×10^{-2}	3×10^{-3}	3×10^{-2}
2,000	2×10^{-3}	2×10^{-4}	2×10^{-3}
20,000	3×10^{-4}	3×10^{-5}	3×10^{-4}

[a]Data compiled from Refs. 4-20 and 4-21.

[b]Fraction of total number of meteorites 1.0 lb or greater.

materials, and various munition components. The EMP field is a short pulse which might contain higher energies due to some uncontrollable phenomenon. Solid-state electrical circuits associated with systems which are national security sensitive are designed for protection from EMP produced electrical energies which could result from atmospheric nuclear blasts. These protection systems generally are designed as a Faraday's cage or have been designed to include "sacrificial" (i.e., expendable) electrical components. However, since nuclear warfare is out of this study's scope, the potential for these levels of energies to exist have been qualitatively screened out as not being credible as potential hazards to control systems. All munitions with the exception of M55 rockets are inherently enclosed in metal that acts as a Faraday's cage for protecting the munition's interrals for normal and stray E-M fields. A Faraday's cage would provide a conducting shield for induced electrical energy which results from E-M fields passing through it. This E-M phenomenon is the basic physics principle, represented by the well-known Maxwell's equations, which enables an electrical generator to change mechanical energy to electrical energy by rotating a conducting system through a magnetic field. Therefore, with the exception of further examination of the possible effects of E-M on M55 rockets, normal or stray E-M fields have been eliminated as a potential initiating event in this hazard analysis.

M55 rockets, and in particular the rocket motors and ignition systems, have been evaluated for their susceptibility to E-M energies or short duration pulses [EMPs in an earlier study (Ref. 4-22)]. M55 rockets warranted special investigation because they contain their own motors and firing systems (igniters), and because of propellant instability which could be increasing as the rockets age. The SAI M55 study (Ref. 4-22) further investigated the rocket's internals and concluded that all the critical components were contained within metallic Faraday's cage type of shields. This study screened out the "rare" event of a simultaneous failure of the igniter's shunt, which prevents electrical energies from reaching the motor, and the existence of an

incident delivering sufficient electrical energy to this M55 rocket. However, if any M55 rockets have a nonworking igniter shunt, then it is not really a case of two simultaneous occurring events. There are guidelines for naval vessels (Ref. 4-23) for maximum radar and communication energies for ensuring that E-M hazards are controlled. Figures 4-15 and 4-16 are from NAVSEA HERO document (Ref. 4-23) and represent the safe field strength and power densities for fully assembled ordnance. These curves are based on experimental results of HERO tests. The boundaries were established by the most susceptible ordnance items. We recommend that further effort be expended in determining whether or not the most sensitive ordnance onboard the naval vessels include items similar to the M55 rockets and in determining what the field strength and power density boundaries mean terms of radio or radar transmission energies which can be more easily understood and enforced.

In summary, E-M and EMP have been screened out as potential sources for plant operations' initiating events; however, further analysis and study are recommended to administratively control the safe demilitarization of munitions well within the safe E-M boundaries.

4.2.3. Internal Events

Table 4-17 summarizes the internal initiating events for the onsite disposal option. Also summarized in the table are the event occurrence frequencies. The bases for these frequencies are discussed in the individual phase sections dealing with the event tree analysis, Sections 5 through 8, and are not repeated here.

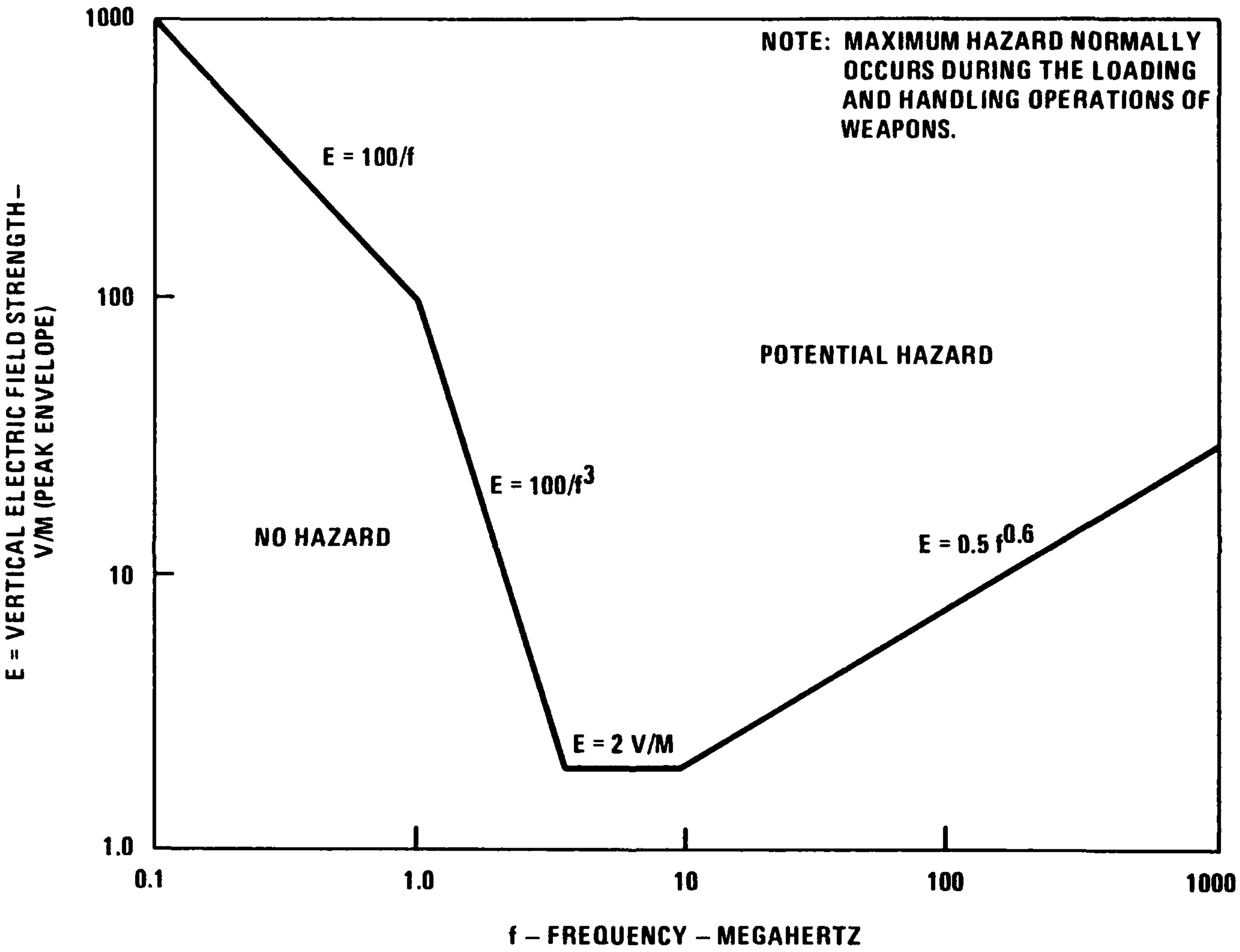

Fig. 4-15. Field intensity potentially hazardous to susceptible weapons which require special restriction - communication frequencies

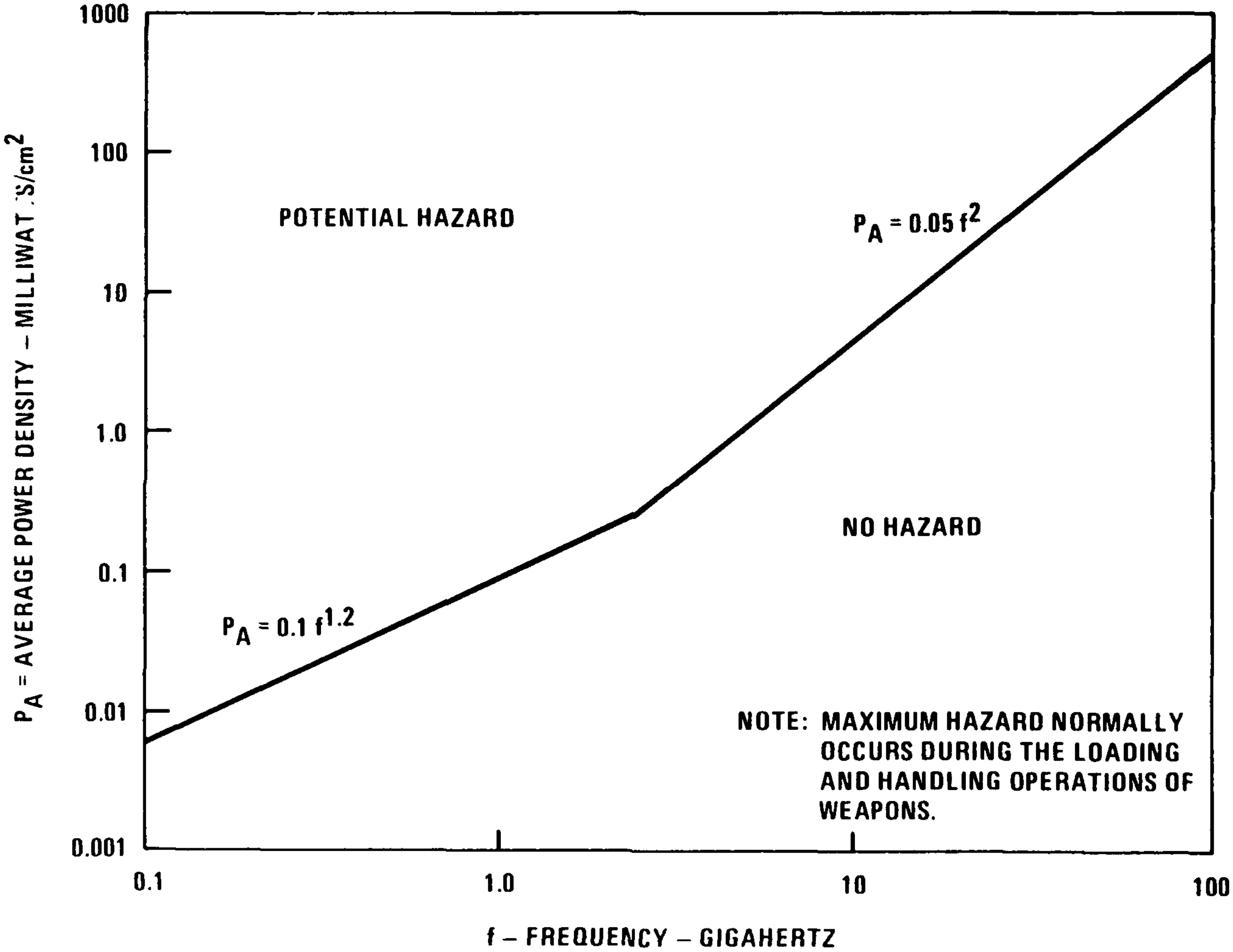

Fig. 4-16. Field intensity potentially hazardous to susceptible weapons which require special restrictions - radar frequencies

TABLE 4-17
LIST OF INTERNAL INITIATING EVENTS AND FREQUENCIES

Event	Frequency		
	Clothing Level		
	A	C	F
STORAGE/HANDLING EVENTS (per operation)			
1. Munition drop from CHE (bulk containers)	3×10^{-5}	1.5×10^{-6}	3×10^{-6}
2. Munition drop from forklift (pallets or ST in overpacks)	3×10^{-4}	1.5×10^{-5}	3×10^{-5}
3. Munition drop from hand (single units)	6×10^{-4}	3×10^{-4}	6×10^{-5}
4. Forklift tine accident	1×10^{-4}	5×10^{-5}	1×10^{-5}
5. Forklift or CHE collision	4.3×10^{-6}	4.3×10^{-6}	4.3×10^{-6}
6. Leak between inspections (stored pallets)	Munition dependent		
7. Leak in ONC or OFC; failure to detect	Munition dependent		

Events	Frequency
TRANSPORT EVENTS	
1. Truck collision or overturn in convoy	1.4×10^{-7}/road mile
2. Truck fire in convoy	2.8×10^{-8}/road mile
3. Train derailment (human error or equipment failure)	5.5×10^{-6}/road mile
4. Aircraft crash at APG	4.2×10^{-7}/yr
5. Aircraft crash at LBAD	1.6×10^{-9}/yr
6. Aircraft crash at TEAD	9.1×10^{-10}/yr

TABLE 4-17 (Continued)

Events	Frequency
7. Barge collision	5.0×10^{-5}/shipment
8. Barge ramming	4.1×10^{-5}/shipment
9. Barge grounding	8.6×10^{-5}/shipment
10. LASH collision, inland LASH collision, coastal LASH collision, sea	1.8×10^{-4}/shipment 8.1×10^{-5}/shipment 1.8×10^{-5}/shipment
11. LASH ramming, inland LASH ramming, coastal LASH ramming, sea	2.5×10^{-5}/shipment 1.7×10^{-5}/shipment 1.3×10^{-5}/shipment
12. LASH grounding, inland LASH grounding, coastal LASH grounding, sea	2.3×10^{-4}/shipment 6.6×10^{-5}/shipment 5.5×10^{-6}/shipment

PLANT OPERATIONS EVENTS

1. Munition spill in ECV	K: 4×10^{-5}/yr R: 3×10^{-7}/yr M: 4×10^{-7}/yr Q: 3×10^{-7}/yr C: 1×10^{-8}/yr P: 6×10^{-7}/yr
2. Munition(s) spill in ECR	1M: 10^{-1}/yr 2M: 10^{-2}/yr 1Q: 10^{-1}/yr 2Q: 10^{-2}/yr 1R: 10^{-2}/yr 2R: 10^{-3}/yr
3. Munition detonates in ECR	M: 4×10^{-4}/yr R: 1×10^{-2}/yr others: 2×10^{-3}/yr
4. Munition(s) spill in MPB	K: 4×10^{-5}/yr Q: 3×10^{-3}/yr 2Q: 3×10^{-4}/yr
5. Ton container spill in BSA	4×10^{-5}/yr
6. Small TOX spill	1×10^{-3}/yr

TABLE 4-17 (Continued)

Events	Frequency
7. Large TOX spill	1×10^{-3}/yr
8. Unpunched bulk item fed to MPF	KH: 1×10^{-9}/yr KV: 6×10^{-1}/yr KG: 9.2×10^{-10}/yr B: 6.4×10^{-9}/yr S: 7.2×10^{-10}/yr

4.3. REFERENCES

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5. SCENARIO LOGIC MODELS FOR STORAGE

5.1. SEQUENCE LIST AND EVENT TREES

The accident sequences involving the interim storage of chemical munitions were categorized as follows:

1. External event-induced agent releases (e.g., earthquakes, aircraft crashes, etc.).

2. Releases due to leakage of munitions while in storage.

3. Releases from accidents that could occur during the isolation of leaking munitions while in storage.

For the onsite disposal option, interim storage refers to the storage of munitions at their original location (in igloos, warehouses, or open yards) before transfer to the demilitarization facility.

Table 5-1 presents the list of accident sequences identified and evaluated for the onsite disposal option. Event tree models are shown in Figs. 5-1 through 5-5. They will be discussed in the following sections by initiating event category. The following notation is used in the event trees:

NR = no release of agent
F = sequence screened based on low frequency criterion
C = sequence screened based on low release criteria

TABLE 5-1
MASTER LIST OF STORAGE ACCIDENTS

Event ID	Description
SL1	Munition develops a leak between inspections.
SL2	Munition punctured by forklift tine during leaker-handling activities.
SL3	Spontaneous ignition of rocket during storage.[a]
SL4	Large aircraft direct crash onto storage area; fire not contained in 30 min. (Note: Assume detonation occurs if burstered munitions hit; fire involving burstered munitions not contained at all.)
SL5	Large aircraft indirect crash onto storage area; fire not contained in 30 min. (See note in SL4.)
SL6	Tornado-generated missiles strike the storage magazine, warehouse, or open storage area; munitions breached (no detonation).
SL7	Severe earthquake breaches the munitions in storage igloos; no detonations.
SL8	Meteorite strikes the storage area; fire occurs; munitions breached (if burstered, detonation also occurs).
SL9	Munition dropped during leaker isolation operation; munition punctured.
SL10	Storage igloo or warehouse fire from internal sources.[a]
SL11	Munitions are dropped due to pallet degradation.[a]
SL12	Liquid propane gas (LPG) infiltrates igloo/building.[a]
SL13	Flammable liquids stored in nearby facilities explode; fire propagates to munition warehouse (applies to NAAP).[a]
SL14	Tornado-induced building collapse leads to breaching/detonation of munitions.[a]
SL15	Small aircraft direct crash onto warehouse or open storage yard; fire occurs; not contained in 30 min.

[a] Screened out for reasons stated in Table 5-2.

TABLE 5-1 (Continued)

Event ID	Description
SL16	Large aircraft direct crash; no fire; detonation (if burstered).
SL17	Large aircraft direct crash; fire contained within 30 min (applies to nonburstered munitions only).
SL18	Small aircraft direct crash onto warehouse or open storage yard; no fire.
SL19	Small aircraft direct crash onto warehouse or open storage yard; fire contained in 30 min.
SL20	Large aircraft indirect crash onto storage area; no fire.
SL21	Large aircraft indirect crash onto storage area; fire contained in 30 min.
SL22	Severe earthquake leads to munition detonation.
SL23	Tornado-generated missiles strike the storage igloo and leads to munition detonation.
SL24	Lightning strikes ton containers stored outdoors.
SL25	Munition dropped during leaker isolation; munition detonates.
SL261	Earthquake occurs; NAAP warehouse is intact; no ton containers damaged; fire occurs.
SL262	Earthquake occurs; NAAP warehouse is intact; ton container damaged; no fire.
S1263	Earthquake occurs; NAAP warehouse is intact; ton container damaged; fire occurs.
SL264	Earthquake occurs; NAAP warehouse is damaged; ton containers damaged; no fire.
SL265	Earthquake occurs; NAAP warehouse is damaged; ton containers damaged; fire occurs.
SL271	Earthquake occurs; TEAD warehouses intact; munitions intact; fire occurs at one warehouse.
SL272	Earthquake occurs; TEAD warehouses intact; munitions intact; fire occurs at two warehouses.

TABLE 5-1 (Continued)

Event ID	Description
SL273	Earthquake occurs; one TEAD warehouse is damaged; munitions intact; fire occurs at one warehouse.
SL274	Earthquake occurs; one TEAD warehouse is damaged; munitions intact; fire occurs at two warehouses.
SL275	Earthquake occurs; two TEAD warehouses damaged; munitions intact; fire occurs at one warehouse.
SL276	Earthquake occurs; two TEAD warehouses damaged; munitions intact; fire occurs at two warehouses.
SL281	Earthquake occurs; UMDA warehouses intact; munitions intact; fire occurs at one warehouse.
SL282	Earthquake occurs; UMDA warehouses intact; munitions intact; fire occurs at two warehouses.
SL283	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; no fire occurs.
SL284	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at warehouse with damaged munitions.
SL285	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at warehouse with undamaged munitions.
SL286	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at two warehouses.
SL287	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; no fire occurs.
SL288	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; fire occurs at warehouse with damaged munitions.
SL289	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; fire occurs at two warehouses.
SL2810	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; no fire occurs.

TABLE 5-1 (Continued)

Event ID	Description
SL2811	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; fire occurs at warehouse with damaged munitions.
SL2812	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; fire occurs at two warehouses.
SL2813	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; no fire occurs.
SL2814	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; fire occurs warehouse with damaged munitions.
SL2815	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; fire occurs at two warehouses.
SL2816	Earthquake occurs; two UMDA warehouses damaged; munitions in two warehouses damaged; no fire occurs.
SL2817	Earthquake occurs; two UMDA warehouses damaged; munitions in two warehouses damaged; fire occurs at both warehouses.

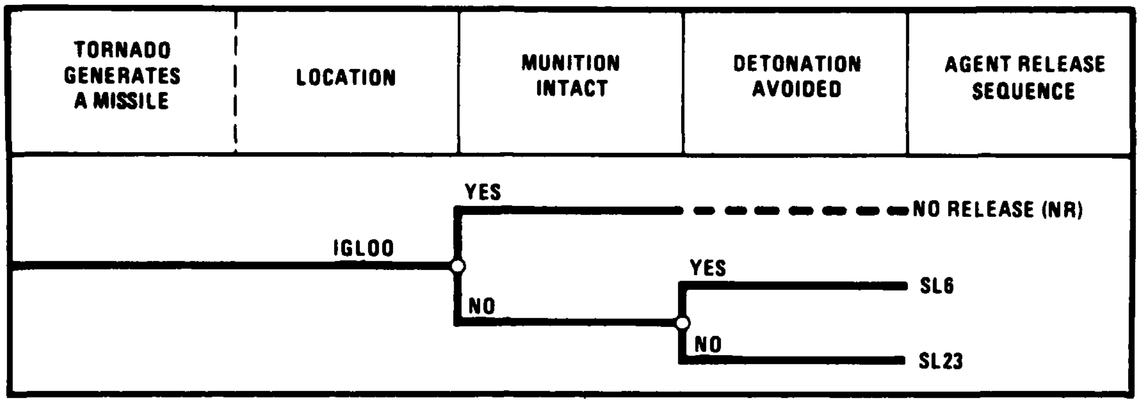


Fig. 5-1. Agent release indicated by tornado-generated missiles

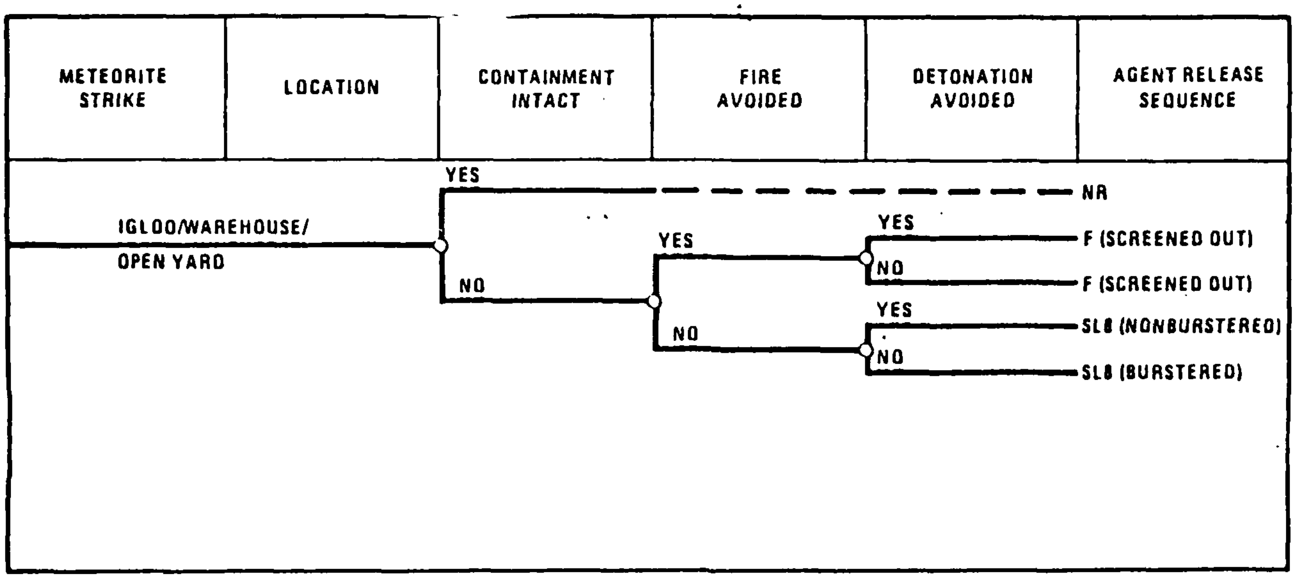


Fig. 5-2. Meteorite-induced agent release

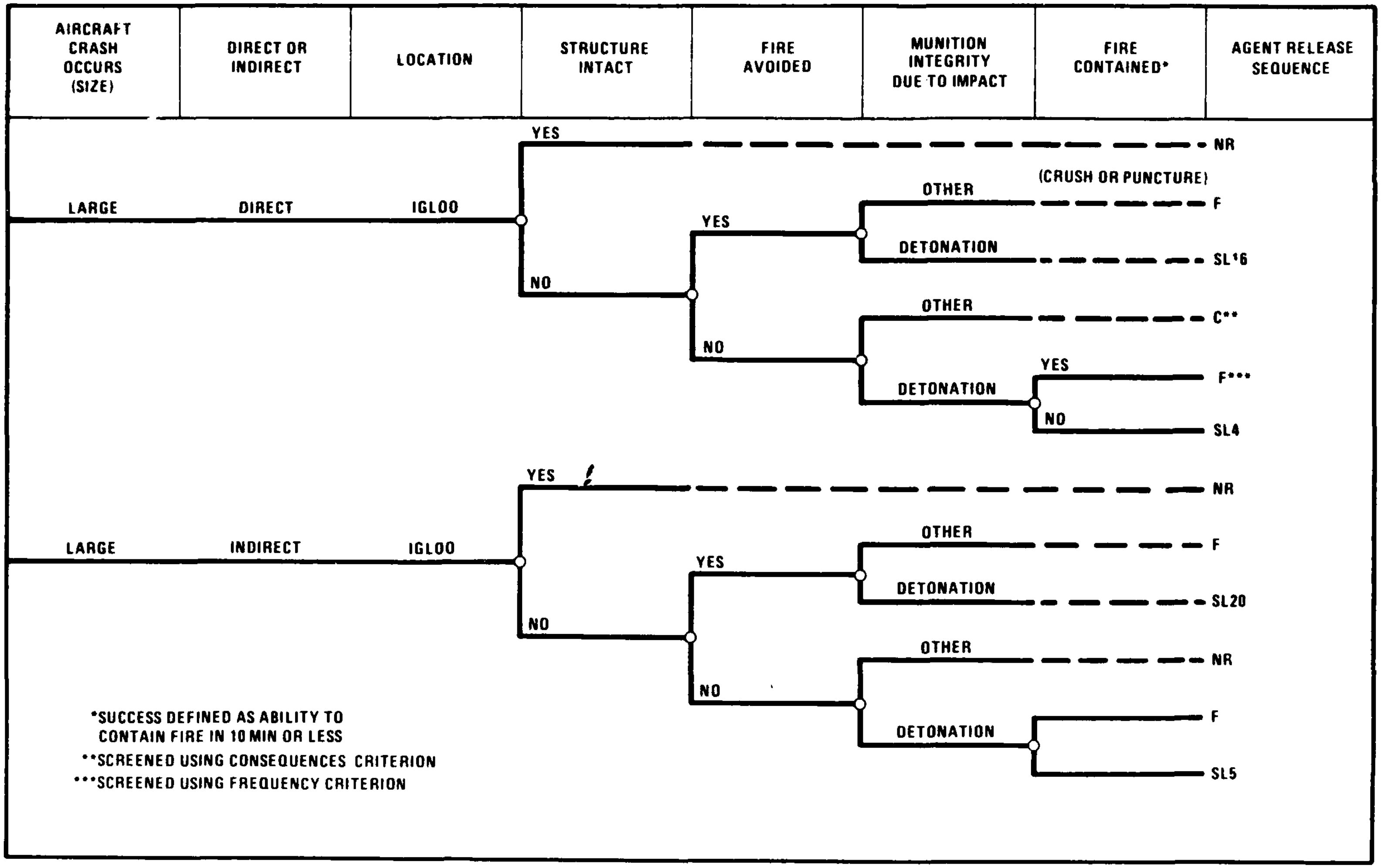


Fig. 5-3. Large aircraft crash onto storage igloos containing burstered munitions

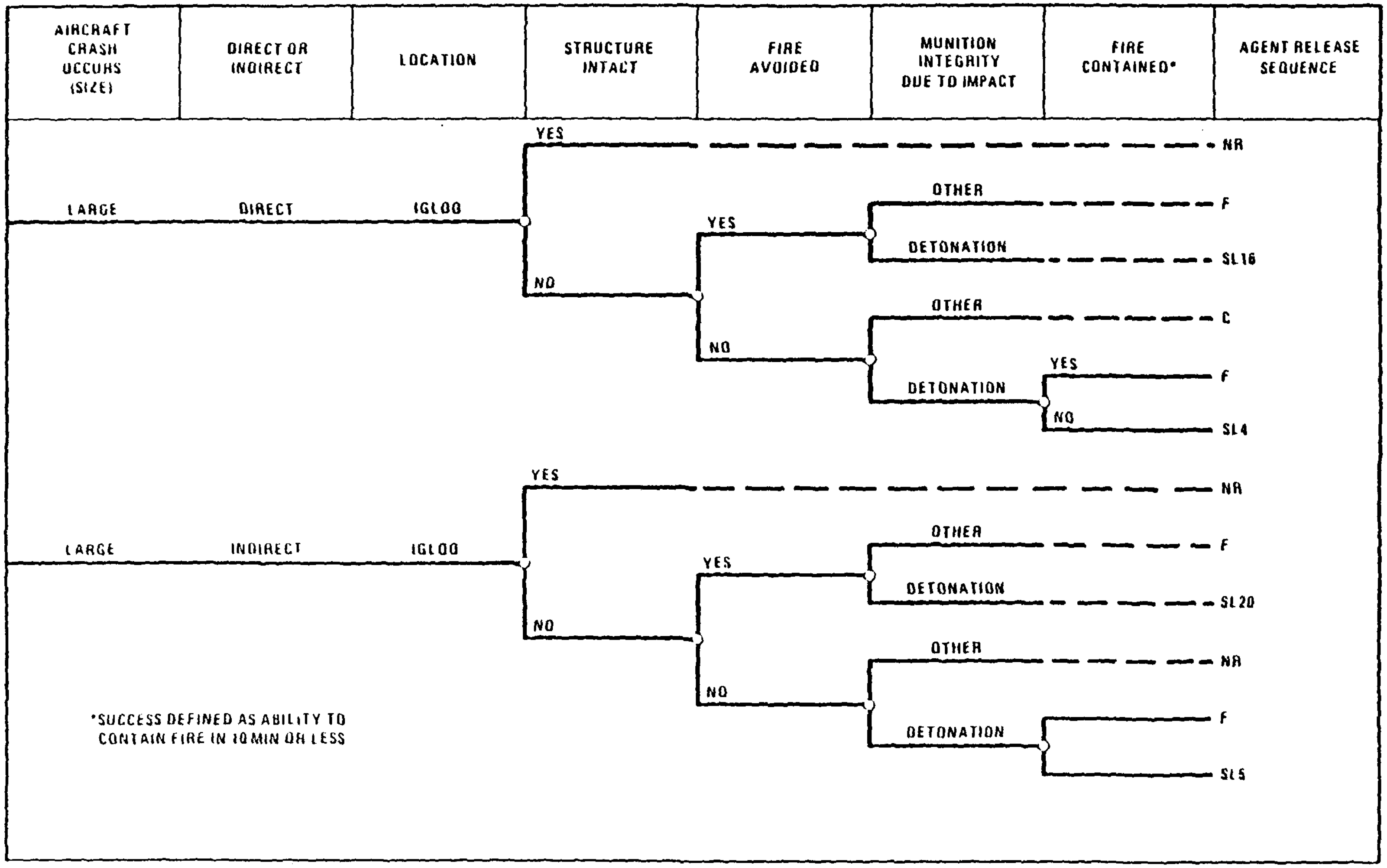


Fig. 5-4. Aircraft crash onto storage facilities with nonburstered (NB) munitions

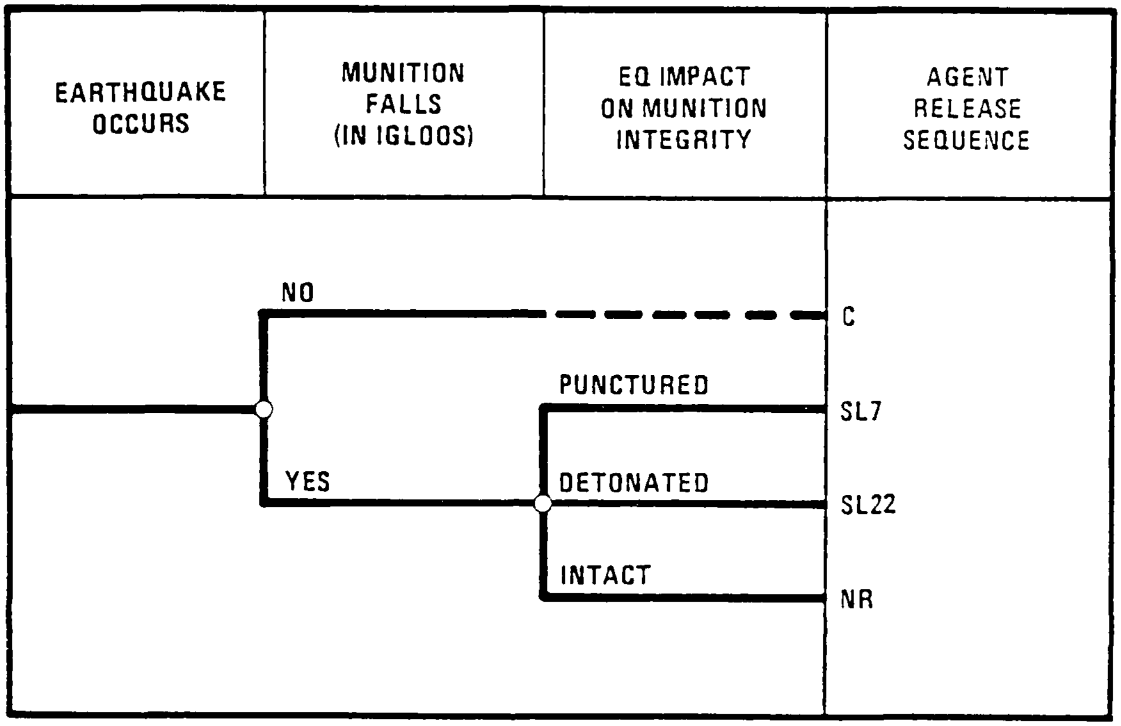


Fig. 5-5. Earthquake-induced agent releases involving munitions in storage igloos

TABLE 5-2
ACCIDENT SEQUENCES ELIMINATED FROM DETAILED ANALYSIS

Accident Sequence	Description	Basis for Elimination
1. SL3	Spontaneous ignition of rocket during storage.	Recent study indicates that the propellant is stable and will continue to be so for some time (Ref. 5-18). There is an enhanced monitoring program to sample propellant in storage. There are also accelerated tests being performed to provide advanced warning of the onset of propellant destabilization.
2. SL11	Munitions are dropped and damaged due to pallet degradation.	The pallets in storage are in very good condition and are expected to remain so for many more years. The munitions are periodically inspected, and if deterioration is observed, the causes are identified and corrected, and the degraded pallet replaced.
3. SL10	Storage igloo or building fire from internal sources.	There is no source of fire in the storage igloos or storage buildings (Ref. 5-1).
4. SL12	Liquid propane gas (LPG) infiltrates igloo/building.	LPG cloud due to release of largest conceivable inventory (35,000 gal) cannot deposit flammable concentration inside the igloo or building (Ref. 5-1).
5. SL13	Flammable liquids stored in nearby facilities explode; fire propagates to munition warehouse (applies to NAAP only).	Several empty storage vessels are located approximately 350 ft from the nearest ton containers outside the exclusion area at NAAP. These tanks were used in conjunction with the former VX production facility. It

TABLE 5-2 (Continued)

Accident Sequence	Description	Basis for Elimination
		is the Army's position to ensure that these tanks will remain empty while munitions are being stored at the NAAP warehouse.
6. (a)	Tornado-induced munition drop leads to munition ignition and detonation.	Calculations indicate that tornado winds at 200 mph will not lift munitions (Ref. 5-2).
7. (a)	Tornado winds lift ton containers and drop them to the ground; container ruptures.	Same as item 6.
8. (a)	A vehicle fire spreads to the storage area/igloo and sets off munitions	Previous analysis indicated that even if the fire was just outside the igloo and the igloo door was open, the munition thermal failure threshold will not be exceeded (Ref. 5-1).
9. (a)	Electrostatic ignition of rocket motor leads to detonation and fire.	Previous study indicated there was no source of spark capable of igniting a rocket motor accidentally (Ref. 5-1).
10. (a)	Electromagnetic pulse (EMP) effects cause detonation.	Previous study concluded there were no sources of EMP of sufficient strength to cause damage to the munitions (Ref. 5-1).

(a) Sequence number not identified in GA's list.

5.2. EXTERNAL EVENTS

The external events that were evaluated include:

- Tornadoes and high winds.
- Meteorite strikes.
- Aircraft crashes.
- Earthquakes.
- Lightnings.
- Floods.

In general, the amount of agent released to the atmosphere from accidents induced by such events depends on the extent of damage incurred to the building structure and the munition itself. The munitions are currently stored in igloos, warehouses, or open storage yards. Appendix D discusses the types of storage structures present at each CONUS site, as well as the kinds of munitions stored.

5.2.1. Tornadoes and High Winds

The accident scenarios identified involve the breaching of the munitions in the storage facilities (i.e., igloos, warehouses, or open yards) by tornado- or high-wind-generated missiles. This failure mode was determined to be more credible than that identified in sequence SL14, which is a tornado/high-wind-induced building collapse that could lead to the crushing of munitions by the falling structure. For UBC designed structures such as a warehouse, the wind loads will fail the walls of the structure before the structure will collapse. Storage igloos have been designed to resist the direct effects of tornadoes with winds up to 320 mph except for the possibility of missiles breaching the igloo doors (Ref. 5-1). For the above reasons, sequence SL14 has been screened out from further analysis.

The event tree developed to define relevant accident sequences is shown in Fig. 5-1. Neither of the accident sequences (SL6 and SL23) could be screened out initially as more detailed quantitative analysis is required to determine the necessary wind velocity to generate missiles which could penetrate the munitions. Hence, both accident sequences shown in the event tree were quantified.

Essentially, the missile penetration of the munition occurs if (1) a tornado or extremely high wind occurs with a velocity sufficient to generate a missile that could penetrate the igloo door, warehouse wall, or transportation container wall, and the munition itself; and (2) the missile actually hits the target munition.

The probability of a missile hitting and rupturing a munition is the product of four variables: (1) the probability that the velocity vector of the missile is nearly perpendicular to the target; (2) the probability that the missile is oriented properly to penetrate the target; (3) the number of missiles per square foot of wind; and (4) the target area. More details on the derivation of these variables are provided in Appendix C and Ref. 5-2.

If the missile hits a burstered munition, two failure modes are possible: (1) the munition is opened up due to puncture or crush, or (2) the missile impact causes munition detonation due to the application of a force greater than the "undue force." The undue force is defined as "a force greater than that generally required to assemble the munition" or as "any force which could cause deformation to the munition (other than minor surface deformation) or damage to the explosive train" (Ref. 5-3).

5.2.1.1. <u>Storage Magazines</u>. The analysis of the vulnerability of the igloo door to the tornado-generated missile considered the two types of igloo doors present at the CONUS sites, i.e., steel and concrete. PBA and TEAD have igloos with either steel or concrete doors, while the

igloos at ANAD, LBAD, PUDA, and UMDA have steel doors only. For conservatism, all igloos at PBA and TEAD were assumed to have concrete igloo doors.

The steel doors require a missile velocity of 94 mph for penetration by a 3-in. steel pipe or 66 mph for penetration by a utility pole. For the concrete doors, the penetration velocity for a 3-in. steel pipe is 66 mph and for the utility pole, 54 mph. After penetrating the door, the remaining missile velocity must be large enough to rupture the munition. The formula for the required initial missile velocity is as follows:

$$V_I = \sqrt{V_d^2 + V_m^2} \quad , \tag{5-1}$$

where V_I = required initial velocity,

V_d = required velocity to penetrate the door,

V_m = required velocity to rupture the munition.

In order for a missile to reach the velocity required to penetrate the igloo door and the munitions inside, a wind with a significantly higher velocity is required. Table 5-3 presents the relationship between wind velocity and missile velocity.

The frequency of a wind-generated missile penetrating an igloo and a munition inside the igloo, is the product of the following:

1. The frequency of a tornado or wind which has sufficient velocity to generate a missile that can penetrate the igloo and munition.

2. The probability of a missile penetrating the igloo and hitting the munition in such a way as to cause damage and is calculated as follows:

$$P_p = P_d \times P_o \times D_e \times A_t \quad , \tag{5-2}$$

TABLE 5-3
WINDBORNE MISSILE VELOCITIES[a]

Design Wind Speed	Horizontal Missile Velocity[b] (mph) 100	150	200	250	300	350	Maximum Height (ft)
Timber plank	60	72	90	100	125	175	200
Three-inch-diameter standard pipe	40	50	65	85	110	140	100
Utility pole	(c)	(c)	(c)	80	100	130	30
Automobile	(c)	(c)	(c)	25	45	70	30

[a] Source: Ref. 5-4.

[b] Vertical velocities are taken as 2/3 the horizontal missile velocity. Horizontal and vertical velocities should not be combined vectorially.

[c] Missile will not be picked up or sustained by the wind, however, for this analysis any initial missile velocity of 80 mph or less was assigned a wind velocity of 250 mph.

where P_d = probability that the velocity of the missile is nearly perpendicular to the target plane,

P_o = probability that the missile is oriented to penetrate the target (i.e., missile not tumbling or going sideways),

D_e = density of number of missiles per square foot of wind,

A_t = target area.

Details on the calculation of these variables are given in Ref. 5-2.

The site-specific tornado frequency versus velocity curves have been presented in Section 4. Two types of missiles were initially considered: (1) a 3-in. pipe and (2) a utility pole. For all munition types, it was found that the utility pole had a higher probability of penetrating munitions.

Tables 5-4 and 5-5 present the wind velocities required to generate missiles which have sufficient velocity to penetrate the igloo door and the various munitions stored inside. Table 5-6 presents the annual frequencies of these winds occurring at each of the sites that have igloos. The frequencies were read from the curves presented in Figs. 4-9 through 4-11. The conditional probability of a missile hitting the igloo door and the munitions stored inside is 3.2×10^{-6} (see Appendix C).

5.2.1.2. Warehouses. The warehouses at TEAD are designed for 100-mph wind loads (Ref. 5-1). Assuming that the warehouses at NAAP and UMDA are designed to the UBC requirements, they should be designed for at least 70 mph winds. An analysis of the UBC requirements shows that

TABLE 5-4
MISSILE PENETRATION THROUGH STEEL IGLOO DOORS AND MUNITIONS

Munition	Missile	Munition Rupture Velocity (mph)	Door Penetration Velocity (mph)	Required Initial Missile Velocity (mph)	Required Wind Velocity (mph)
Ton container	3-in. pipe	108	94	143	>350
	Utility pole	67	66	94	285[a]
4.2-in. mortar	3-in. pipe	60	94	112	303
	Utility pole	8	66	67	250[a]
750-lb bomb	3-in. pipe	101	94	138	347
	Utility pole	63	66	91	278[a]
8-in. projectile	3-in. pipe	162	94	187	>350
	Utility pole	25	66	71	250[a]
M23 land mine	3-in. pipe	43	94	103	286
	Utility pole	6	66	66	250[a]
M55 rocket	3-in. pipe	22	94	97	274
	Utility pole	8	66	67	250[a]

[a] Critical missile for munition.

TABLE 5-5
MISILE PENETRATION THROUGH CONCRETE IGLOO DOORS AND MUNITIONS

Munition	Missile	Munition Rupture Velocity (mph)	Door Penetration Velocity (mph)	Required Initial Missile Velocity (mph)	Required Wind Velocity (mph)
Ton container	3-in. pipe	108	66	127	329
	Utility pole	67	54	86	285[a]
4.2-in. mortar	3-in. pipe	60	66	89	258
	Utility pole	8	54	55	250[a]
750-lb bomb	3-in. pipe	101	66	121	318
	Utility pole	63	54	83	258[a]
8-in. projectile	3-in. pipe	162	66	175	>350
	Utility pole	25	54	60	250[a]
M23 land mine	3-in. pipe	43	66	79	235[a]
	Utility pole	6	54	54	250
M55 rocket	3-in. pipe	22	66	70	213[a]
	Utility pole	8	54	55	250

[a]Critical missile for munition.

TABLE 5-6
FREQUENCY (PER YEAR) OF A WIND HAZARD SUFFICIENT TO BREACH MUNITIONS IN STORAGE MAGAZINES[a]

	ANAD	LBAD	PBA[b]	PUDA	TEAD[b]	UMDA
Cartridges and mortars	1.5E-6	--	--	1.0E-7	1.8E-9	--
Projectiles	1.5E-6	1.5E-6	--	1.0E-7	1.8E-9	1.8E-9
Mines	1.5E-6	--	2.6E-6	--	4.2E-9	1.8E-9
Rockets	1.5E-6	1.5E-6	6.1E-6	--	1.5E-8	1.8E-8
Ton containers	3.8E-7	--	--	--	7.5E-10	2.4E-10
Bombs	--	--	--	--	1.1E-9	3.6E-10
Spray tanks	--	--	--	--	--	1.1E-9

[a]FREQUENCIES obtained from the curves presented in Figs. 4-9 through 4-11.

[b]Concrete doors.

winds will fail the walls of UBC designed structures before the frame of the structure will fail. Based on the margins of safety required by the UBC, the concrete walls of the warehouses at TEAD are not expected to be breached by winds less than 160 mph. Breaching of the concrete walls is expected to involve cracking and spalling of the concrete and the possibility of the wall partially separating from the frame. The sheet metal walls of the warehouses at NAAP and UMDA are expected to be blown away by 115-mph winds. Neither of these failures are expected to damage the bulk containers.

In order for a wind blown missile to penetrate a spray tank in a warehouse at TEAD, it must pass through the 6-in. concrete wall, the spray tank overpack, and finally the spray tank itself. This would require a 283-mph wind.

A 250-mph wind can generate a missile that will penetrate an unprotected ton container. Since a 115-mph wind is expected to blow away the walls of the warehouses at NAAP and UMDA, the walls will offer no protection. Therefore, a 250-mph wind has the potential to generate missiles that will penetrate the ton containers stored in these warehouses. Table 5-7 presents the frequency of occurrence of such winds at these sites. The conditional probability of a missile hitting a ton container in an orientation which could breach the container is 2.2×10^{-4} at NAAP and 2.7×10^{-4} at UMDA (see Appendix C).

5.2.1.3. Open Storage. Ton containers are stored in open storage at APG, PBA, and TEAD. A wind velocity of 250 mph is required to generate a missile that can penetrate these ton containers. The frequencies of generating the 250-mph wind are presented in Table 5-7. The conditional probability of a missile hitting a ton container in an orientation which could breach the container is 6.6×10^{-4} (see Appendix C).

5.2.1.4. Tornado-Generated Missiles Cause Munition Detonation. The analysis of scenario SL23 included the estimation of the probability

TABLE 5-7
FREQUENCIES FOR WIND-GENERATED MISSILE PENETRATION
OF TON CONTAINERS AND SPRAY TANKS STORED IN
WAREHOUSES AND OPEN STORAGE

Site	Storage	Required Wind	Frequency of Wind	Probability of Hitting and Rupturing TC
APG	Open	250	1.0E-7	6.6E-4
PBA	Open	250	1.5E-6	6.6E-4
NAAP	Warehouse[a]	250	1.5E-6	2.2E-4
UMDA	Warehouse[a]	250	1.8E-9	2.7E-4
TEAD	Warehouse[b]	283	2.7E-10	4.4E-4

[a] Metal walls.

[b] Concrete walls.

that a missile impacting a munition would cause it to detonate or in the case of rockets, cause the rocket motor to ignite and subsequently detonate the burster. The data presented in Ref. 5-5 indicated that a projectile with Comp B explosive could ignite when subjected to a minimum impact velocity of 123 mph. Because the conditions of the tests described in Ref. 5-5 do not fully apply to the conditions being considered here (i.e., the shell casing provides protection for the bursters), it is assumed that there is a 50% chance that a munition will detonate at 123 mph. Furthermore, Army data indicate that dropping of thousands of burstered munitions from 40 ft did not lead to any detonations (Ref. 5-6). However, these are newer munitions and do not fully represent the chemical munitions in the stockpile. Therefore, based on the consensus of risk experts (Ref. 5-7), an estimated probability of 10^{-6}/munitions were assigned to all drops of 6 ft or lower (equivalent to a free fall drop of 13.5 mph). To determine the probability of detonating a munition at an impact velocity equivalent to that of a missile required to penetrate the igloo and the munition, we assumed a lognormal distribution and derived the necessary parameters (e.g., standard deviation and standard normal deviate) from these two data points. The calculation details are given in the calculation sheets (Ref. 5-2).

The overall frequency for this scenario is the product of the following:

1. The frequency of a tornado or wind which has sufficient velocity to generate a missile that can penetrate the igloo and munition.

2. The probability of a missile penetrating the igloo and hitting the munition in such a way as to cause damage.

3. The probability of burster detonation from impact.

The values for the first two variables have already been presented in Section 5.2.1.1. The probability of a detonation given penetration of burstered munitions stored inside the igloos with steel doors is 0.07 and for concrete doors, 0.055. See Ref. 5-2 for calculations.

5.2.2. Meteorite Strikes

Like tornado-generated missiles, meteorites striking the igloos, warehouses, and the outdoor yards can lead to a significant amount of agent release. The consequence of such an accident is more severe than that from a tornado-generated missile because meteorite strikes generally involve fires. Hence, if burstered munitions are involved, explosive detonations could occur from the fire or from direct impact, leading to instantaneous agent releases.

The event tree developed for meteorite-initiated accidents is shown in Fig. 5-2. The scenarios could not be subjected to any preliminary screening without doing a more detailed analysis of the what type (stone or iron) and size of meteorite is capable of penetrating munitions stored igloos, warehouses, or outdoors. The only identified accident sequence is SL8.

Storage Magazines

In this sequence (SL8), the meteorite penetrates the storage magazine and ruptures some of the munitions stored inside. The meteorite is expected to be sufficiently hot to cause ignition of the exposed burster, propellant, and/or agent. The fire is expected to spread, resulting in the destruction of the entire inventory of the storage magazine.

Warehouses

This scenario is similar to the storage magazines. The meteorite penetrates the warehouse and ruptures some of the bulk munitions stored inside. The meteorite causes the ignition of the exposed agent. Fire spreads and results in the destruction of the entire warehouse inventory.

Open Storage

In this scenario, the meteorite directly impacts and ruptures some ton containers. The heat from the meteorite is expected to ignite the exposed agent, but is not expected to cause the rupture of additional munitions.

5.2.2.1. Meteorite Strike Accident Analysis. About 3500 meteorites, each weighing over 1 lb, strike the earth each year; the majority of them are of small sizes (Ref. 5-8). Given the earth's surface area of 5.48×10^{15} ft^2, the frequency of meteorite strikes for meteorites weighing 1.0 lb or greater is $6.4 \times 10^{-13}/ft^2$ (Ref. 5-8). For meteorites one ton or less, stone meteorites are approximately 10 times more common than iron. However, iron meteorites are more dense and tend to have higher impact velocities and therefore represent a significant portion of the total meteorites that can rupture the munitions. Table 4-16 shows the size distribution of both iron and stone meteorites. The table was compiled from data presented in Refs. 5-8 and 5-9.

For agent to be released, the meteorite has to penetrate the storage structure and the munition wall. In the case of an igloo, this would require initial penetration of a 6-in. concrete roof. The minimum meteorite impact velocity that would collapse the earth cover and the 6-in. concrete roof is 1500 fps for stone meteorite and 3800 fps for

iron meteorite. The overall frequency of a meteorite capable of penetrating and rupturing the munitions in the igloo is:

$$P = F\ (F_s + F_i)\ A \times S \quad , \tag{5-3}$$

where F = the frequency of a meteorite weighing one pound or more striking the earth, $6.4 \times 10^{-13}/ft^2$,

F_s = fraction of stone meteorites which can penetrate the target,

F_i = fraction of iron meteorites which can penetrate the target,

A = target area (igloo, warehouse, or open storage yard,

S = spacing factor.

Table 5-8 presents the frequencies for meteorite penetration of munitions stored in the various storage configurations along with the size of the meteorites required to penetrate the munitions and the data required to evaluate Eq. 5-3. Supporting calculations are presented in Ref. 5-2, and the methodology is discussed in Appendix C.

5.2.3. Aircraft Crashes

The sequences describing the effects of an aircraft crash on munitions in storage are SL4, SL5, SL15, SL16, SL17, SL18, SL19, SL20, and SL21.

The effects of large (>12,500 lb) and small (12,500 lb or less, including helicopters) aircraft crashes on the munitions in storage igloos, warehouses, and open yards were evaluated. Because of the potential for large quantities of fuel to be carried by large aircraft and the potential for large, high-velocity missiles (e.g., engines), the large aircraft crash scenarios were further divided into direct and indirect crashes. For direct and indirect large aircraft crashes onto the storage area that do not result in fire, it is assumed that the

TABLE 5-8
METEORITE REQUIRED FOR PENETRATION OF MUNITIONS IN STORAGE

Storage Area	Munition	Stone Meteorite Weight (lb)	Stone Meteorite Fraction (fs)	Iron Meteorite Weight (lb)	Iron Meteorite Fraction (fi)	Target Area (ft^2) (A)	Spacing Factor (s)
Igloo	All	1,000	0.02	200	0.003	960	0.5
Warehouse-NAAP	Ton container	20	0.11	2	0.03	22,000	0.5
Warehouse-UMDA	Ton container	20	0.11	2	0.03	46,000	0.4
Warehouse-TEAD	Spray tank	100	0.08	10	0.02	67,000	0.4
Open	Ton container	20	0.11	2	0.03	139[a]	1.0

[a]Area of one pallet (15 ton containers stacked two high).

[b]700 x 220 ft (Ref. 5-10).

impact of the crash is strong enough to cause the detonation of burstered munitions.

For a small aircraft crash adjacent to the storage site to produce a credible event, the crash would have to be so close that it would virtually be a direct hit. Therefore, the small aircraft crash scenarios address only direct hits into the storage areas including holding areas.

The event trees developed to identify the agent release scenarios from aircraft crashes are shown in Figs. 5-3 and 5-4.

5.2.3.1. Aircraft Crash Accident Analysis. In summary, the following general assumptions were made in deriving the large/small aircraft accident scenarios:

1. For large aircraft crashes onto burstered munitions, it is assumed that detonations will occur for both indirect and direct hits, and, if a fire occurs, it is uncontained.

2. No small aircraft crashes were assumed to be able to sufficiently damage the igloo to cause agent releases.

Direct Crash of Large Aircraft Sequences (SL4, SL16, SL17)

For a direct aircraft crash, the target area is the surface area of the building or open yard.

Storage Magazines. The direct crash of the main body of a heavy military or commercial aircraft into the shell or front face of a storage magazine (igloo) can breach the igloo and allow crash-generated missiles and/or aviation fuel to enter into the igloo. There is a high probability that one or more munitions will be crushed or punctured by the missiles. Burstered munitions could also detonate from impact. If

the crash produces a fire, the fire is expected to spread through the igloo, resulting in the destruction of the entire igloo inventory.

Warehouses. A warehouse is not expected to offer any substantial resistance to crash of a large aircraft. The direct impact of any part of a large aircraft will breach the warehouse and subject the stored munitions to crash-generated missiles. Bulk containers will be crushed or punctured. If the crash produces a fire that is not contained, the destruction of the entire inventory is expected.

Open Storage. The crash of a large aircraft into an open area is expected to breach a large number of ton containers. If the crash produces a fire, and it is not contained, it is expected to breach additional containers in the immediate vicinity of the initial container that is on fire.

Indirect Crash of a Large Aircraft Sequences (SL5, SL20, SL21)

For an indirect crash, the target area is determined by increasing all perimeters for the direct crash by 200 ft.

Storage Magazines. Should a large aircraft crash adjacent to an igloo, the area that is most vulnerable is the igloo door. The crash-generated missiles can breach the igloo door which essentially provides a pathway to the breaching of munitions in the line of site of the missile. Alternatively, the igloo door may already be open at the time of the crash and the missile could directly penetrate the munitions. If fire is involved, the missile could already be on fire or the fire could propagate into the igloo opening. Thus, if fire is not contained, the amount of agent release is the same as for the direct crash of a large aircraft into an igloo.

Warehouses. The designs of the warehouses are such that the crash of a large aircraft into an area adjacent to a warehouse may also breach

the warehouse if the aircraft is flying towards the warehouse at the time of the crash. The amount of munitions that are initially impacted would be less than the direct crash scenario. However, if fire is involved and uncontained, the amount of agent release is the same as for the direct crash of large aircraft into a warehouse.

Open Storage. The accident scenario for the crash of a large aircraft into an area adjacent to the open storage area considers that there is a 50% chance that some ton containers would be breached by the crash-generated missile. If fire is involved and not contained, additional containers would rupture due to excessive heating.

Direct Crash of a Small Aircraft Sequences (SL15, SL18, SL19)

Storage Magazines. Due to the high strength of the storage magazine, the crash of a small aircraft is not expected to breach an igloo or affect the structural integrity of an igloo.

Warehouses. The crash of a small aircraft into a warehouse would very likely breach the warehouse. The resulting crash-generated missiles are expected to crush or puncture some munitions. If the crash produces a fire and it is not contained, the fire would involve the entire inventory.

Open Storage. The crash of a small aircraft into an open storage area is similar to the large aircraft crash into an open storage area except a smaller number of ton containers is breached.

5.2.3.2. Aircraft Crash Frequency. The frequency of an aircraft crashing while in an airway or in the vicinity of an airport can be computed as shown in Section 4.2.1.3.

The annual frequency of a crash into a specific facility was computed by multiplying the appropriate frequency taken from Table 4-13 by the effective target area of the facility (see Appendix C). Table 5-9 summarizes these annual frequencies. The calculations of the effective areas are contained in Ref. 5-2 and take into account such factors as aircraft wing span, facility height, and facility vulnerability.

5.2.3.3. Probability of Fire Resulting From An Aircraft Crash. The probability of a fire resulting from the crash has been estimated to be 0.45 (Ref. 5-11). The successful containment of the fire is defined here to be 0.5 h for unpackaged nonburstered munitions. This time was selected based on the thermal failure threshold data presented in Appendix F, which indicate that direct heating of ton containers for 36 min leads to hydraulic rupture. For unpackaged burstered munitions, the thermal failure threshold range from 4 min for rockets to 23 min for mines. Since the Army policy is not to fight a fire involving direct heating of burstered munitions, the probability of the "failure to contain fire" event is essentially 1.0.

Thus, the amount of agent released from bulk containers subjected to aircraft crash fires depends on the ability to contain the fire. If fire is allowed to progress for more than 30 min, more containers will rupture.

The ability of the fire-fighting team to extinguish an aircraft crash fire depends on many variables such as the precise crash site, the burn time of the resulting fire, the availability of resources necessary to contain the fire, etc. If fire fighters arrive at the crash site in a relatively short period of time, the fire will be easier to extinguish since it is not likely to have spread very far. Because the fire will involve chemical agent, additional precautions will have be taken before the fire-fighting team can start extinguishing the fire. Their arrival at the perimeter of the MDB or MHI is assumed to occur about 5 min after the crash. The crew will have to put on agent protective clothing in

TABLE 5-9
DATA BASE FOR AIRCRAFT CRASH-INITIATED SCENARIOS FOR STORAGE

24-Jul-87

DATA BASE FOR AIRCRAFT CRASH-INITIATED SCENARIOS FOR STORAGE

EVENT	VARIABLE ID	FREQUENCY OR PROBABILITY	UNIT	ERROR FACTOR	REFERENCE
Large aircraft direct crash storage area:					
ANAD - 60 FT IGLOO	LDANI60	4.5E-10	per facility	10	Ref. 5-2
ANAD - 80ft igloo	LDANI80	6.0E-10	year	10	
APG - open	LDAPOP	1.4E-09		10	
LBAD - 89ft igloo	LDLBI89	3.7E-10		10	
NAAP - wh	LDNAWH	3.6E-09		10	
PBA - 80ft igloo	LDPBI80	1.1E-10		10	
- open	LDPBOP	1.7E-08		10	
PUDA - 80 ft igloo	LDPUI80	4.5E-09		10	
TEAD - 80 ft igloo	LDTEI80	2.7E-11		10	
- 89 ft igloo	LDTEI89	3.0E-11		10	
- wh	LDTEWH	8.7E-10		10	
- open	LDTEOP	7.9E-09		10	
UMDA - 80 ft igloo	LDUMI80	1.1E-09		10	
- wh	LDUMWH	2.5E-08			
Large aircraft indirect crash :					
ANAD - 60 ft igloo	LAANI60	5.5E-08	per facility	10	Ref. 5-2
ANAD - 80ft igloo	LAANI80	5.7E-08	year	10	
APG - open	LAAPOP	9.4E-09		10	
LBAD - 89ft igloo	LALBI89	3.0E-08		10	
NAAP - wh	LANAWH	5.0E-08		10	
PBA - 80ft igloo	LAPBI80	1.1E-08		10	
- open	LAPBOP	3.5E-08		10	
PUDA - 80 ft igloo	LAPUI80	4.0E-07		10	
TEAD - 80 ft igloo	LATEI80	2.6E-09		10	
- 89 ft igloo	LATEI89	2.7E-09		10	
- wh	LATEWH	7.9E-09		10	
- open	LATEOP	1.0E-08		10	
UMDA - 80 ft igloo	LAUMI80	1.1E-07		10	
- wh	LAUMWH	1.3E-07		10	
Igloo breached given direct crash	ID	8. E-01	none	1.4	EJ
Igloo breached given indirect crash	IA	2.0E-03	none	3	Ref. 5-2
Wrhse-outdoor contnr brched (dir. crash)	WHD	1.0E+00	none	none	EJ
Wrhse brchd given indirect crash	WHA	1.7E-01	none	2	Ref. 5-2
Outdoor contnr brchd (indir. crash)	OA	5.1E-01	none	1.4	Ref. 5-2
Crash does not involve fire	NF	5.5E-01	none	none	Ref. 5-11

TABLE 5-9 (Continued)

DATA BASE FOR AIRCRAFT CRASH-INITIATED SCENARIOS FOR STORAGE

EVENT	VARIABLE ID	FREQUENCY OR PROBABILITY	UNIT	ERROR FACTOR	REFERENCE
Crash results in fire	YF	4.5E-01	none	none	Ref. 5-11
Fire not contnd in 1/2 hr (burstrd)	FNCB	1.0E+00	none	none	Ref. 5-2 and Appendix J
Fire contnd in 1/2 hr (nonburstrd)	FCNB	3.4E-04	none	3	Ref. 5-2 and Appendix J
Fire not contnd in 1/2 hr (nonburstrd)	FNCNB	1.0E+00	none	none	Ref. 5-2 and Appendix J
Fire contained (wh or op) small	SFNB	1.9E-02	none	3	Ref. 5-2
Small aircraft crash warehouse NAAP	SANAAP	1.8E-08	per year	10	Ref. 5-2
Small aircraft crash warehouse UMDA	SAUMDA	2.0E-08		10	Ref. 5-2
Small aircraft crash warehouse TEAD	SATEAD	3.3E-08		10	Ref. 5-2
Small aircraft crash open APG	SAOAPG	3.6E-05		10	Ref. 5-2
Small aircraft crash open PBA	SAOPBA	1.3E-06		10	Ref. 5-2
Small aircraft crash open TEAD	SAOTEAD	3.2E-07		10	Ref. 5-2

addition to their normal, fire-fighting suits of thermal protective clothing. Donning these clothes and checking for proper mask fit would take several more minutes, if it is assumed that the crew was partially dressed; i.e., in a standby readiness mode. Because of all the detection, observation, communication, preparation, and travel tasks involved, it is estimated that it would take the fire-fighting team 15 min to get to the scene of the fire.

Once at the scene, the time it takes to actually extinguish the fire is difficult to estimate. GA interviewed local fire fighting personnel to get their opinion on how long it takes to extinguish a fire from a small aircraft crash versus large aircraft crash. No definite time can be given because of the many variables involved. But based on local experience, it would take 1 to 3 h to extinguish a fire from a small aircraft; while it would take 3 to 10 h for a large aircraft fire. Using the lognormal distribution, GA then derived the probability of containing the fire in 0.5 h or less and took no credit for the first 15 min of the fire. More details are provided in the calculation sheets (Ref. 5-2).

5.2.4. Earthquakes

5.2.4.1. Storage Magazines. The earthquake-initiated accident affecting the storage igloos assumes that the earthquake causes the munitions in the igloo to fall and be punctured given the presence of a probe on the igloo floor or the fall could cause a burstered munition to detonate (Sequence SL7). This sequence is modeled using the event tree illustrated in Fig. 5-5.

The storage magazines are expected to survive the largest credible earthquake with little or no damage. Some cracking or spalling of the concrete is possible, but this should not produce a threat to the munitions or significantly change the containment capability of the magazine. Igloos have been tested by very large external explosions and

have survived without damage (Ref. 5-12). The data from these tests indicate that the igloo experienced accelerations which were in excess of 20 g. Though an explosion is not as potentially damaging to an igloo as an earthquake of equal acceleration, the similarities are sufficient to conclude that a very large earthquake, in the range of 1.0 g, is not likely to damage an igloo.

Sequence SL7 postulates that the earthquake causes the stacked munitions to fall and may be punctured upon impact. Based on the coefficient of friction between pallets of munitions, a 0.3-g earthquake will likely cause some stacked munitions to fall and a 0.5-g earthquake will cause a large number to fall. The highest stacked munitions in an igloo can potentially fall 6 ft. The munition failure threshold data indicate that all palletized munitions and bulk containers can survive the impact of a drop from this height but could be punctured if they were to land on a probe which was sufficiently sharp and rigid. For this analysis a 0.3-g earthquake was assumed to cause 25% of the stacked pallets to fall while a 0.5-g earthquake will cause 100% of the stacked pallets to fall. The number of pallets which have the potential of impacting a probe was estimated for each munition type based on (1) how the pallets are stacked and (2) the floor area available for the pallets to fall. The calculation details are provided in Ref. 5-2.

The analysis of the presence of a probe in the igloo has indicated that it is unlikely that a probe inside the igloo that is sufficiently rigid and sharp to damage a munition. Table 5-10 provides the earthquake frequency data for each of the eight sites and the puncture probability of a munition type given a 6-ft drop.

Sequence SL22 involves the detonation of burstered munitions resulting from an earthquake-induced fall. The probability of a munition detonating from a 6-ft drop is estimated using the same approach discussed for detonations due to impact by wind-generated missiles.

TABLE 5-10
DATA BASE FOR ANALYSIS OF EARTHQUAKE-INDUCED AGENT RELEASE IN THE STORAGE IGLOOS

	Map Area 5 Site: TEAD	Map Area 2 Site: ANAD, LBAD, PBA, UMDA, and PUDA
Earthquake frequency (/yr) at		
0.3 to 0.5 g (F_1)	6.0E-4	1.9E-5
>0.5 g (F_2)	1.0E-4	6.0E-6
Probability stacked pallets will fall at		
0.3 to 0.5 g (P_1)	0.25	0.25
>0.5 g (P_2)	1.0	1.0

	Number of Munitions Falling At	
Munition Type	(N_1) 0.3 to 0.5 g	(N_2) >0.5 g
Bomb	3	11
105-mm cartridge	5	20
4.2-in. mortar	5	18
Ton container	6	22
Mine	4	14
Projectile	11	46
Rocket	5	20
Spray tank	N/A	N/A

SL7 (accident frequency) = $(F_1 * P_1 * N_1) + (F_2 * P_2 * N_2)$

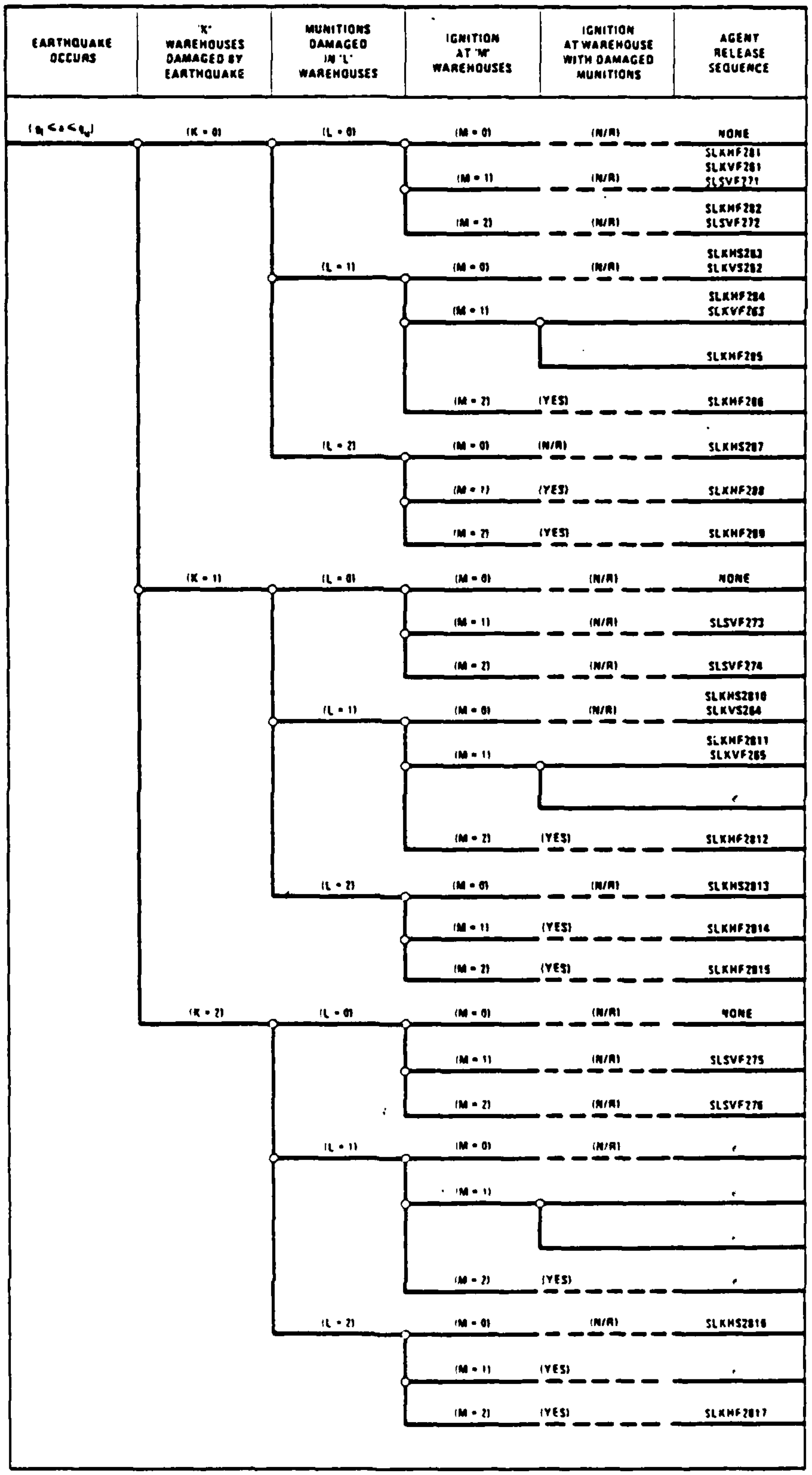


Fig. 5-6. Earthquake-induced releases from the warehouses

5.2.4.2. Warehouses. The event tree describing release scenarios resulting from earthquake-induced accidents in warehouses is shown in Fig. 5-6. The event tree applies to the long-term storage warehouses at TEAD, NAAP, and UMDA. Spray tanks are stored at the two warehouses at TEAD. Ton containers are stored at NAAP in one warehouse and at UMDA in two adjacent warehouses.

Accident scenarios describing releases from long-term storage warehouses are given in Table 5-11. Scenario designations are SLxxx26x for the NAAP warehouse, SLxxx27x for the TEAD warehouses, and SLxxx28x for the warehouses at UMDA. The accident sequence designations are also shown on the event tree in Fig. 5-6. For those accident scenarios where no agent release occurs, the release scenario is labeled "NR." Those release scenarios whose frequency is below 1.0×10^{-10} for all sites have been screened using the frequency criterion and labeled with an "F" in the event tree. The events modeled in Fig. 5-6 are discussed below:

1. Earthquake Occurs. The initiating event (Event 1) in Fig. 5-6 is earthquake occurrence. To simplify the event tree evaluation, Event 1 further restricts the earthquake intensity to an acceleration range from g_l (0.15 to 0.2 g) to g_u (>0.7 g). Seven ranges are considered:

   a. 0.15 to 0.2 g.
   b. 0.2 to 0.3 g.
   c. 0.3 to 0.4 g.
   d. 0.4 to 0.5 g.
   e. 0.5 to 0.6 g.
   f. 0.6 to 0.7 g.
   g. Greater than 0.7 g.

TABLE 5-11
EARTHQUAKE-INDUCED ACCIDENTS IN WAREHOUSES

Agent Release Sequence	Median Frequency (per Year)
SLSVF 271	2.7E-04
SLSVF 272	8.3E-06
SLSVF 273	3.1E-05
SLSVF 274	1.9E-06
SLSVF 275	7.0E-07
SLSVF 276	4.8E-08
SLKVF 261	1.1E-06
SLKVS 262	9.5E-07
SLKVF 263	1.1E-09
SLKVS 264	3.3E-04
SLKVF 265	1.4E-04
SLKHF 281	4.8E-07
SLKHF 282	6.3E-05
SLKHS 283	1.9E-07
SLKHF 284	3.1E-10
SLKHF 285	3.1E-10
SLKHF 286	F
SLKHS 287	8.5E-10
SLKHF 288	F
SLKHF 289	F
SLKHS 2810	1.4E-05
SLKHF 2811	2.9E-05
SLKHF 2812	1.2E-07
SLKHS 2813	7.6E-08
SLKHF 2814	6.9E-08
SLKHF 2815	3.6E-10
SLKHS 2816	5.6E-05
SLKHF 2817	1.1E-05

NOTE: F denotes extremely low frequency.

Earthquakes below 0.15 g are not considered in the analysis because the damage probabilities associated with such tremors are negligibly small. Detailed examination of seismic ranges above 0.7 g is unnecessary because earthquakes above 0.7 g have a probability of almost 1.0 of causing damage.

The initiating event frequency at each site is the site-specific frequency at which earthquakes in the range gl to gu occur.

2. <u>"K" Warehouses Damaged by Earthquake</u>. Warehouse damage is defined as structural collapse. This is the only failure mode of interest because it will crush stored ton containers. Although less severe damage can result from an earthquake, it was screened in quantifying the Event 2 probability because it does not induce ton container failure.

Three damage combinations are considered in Event 2:

a. No warehouses are damaged (K = 0).
b. Only one warehouse is damaged (K = 1).
c. Both warehouses are damaged (K = 2).

Tracking these three probabilities is necessary in order to estimate the agent release source term. Note that since there is only one warehouse at NAAP, the probability that K = 2 is zero for that site.

Event 2 damage probabilities are based upon a generic study of damage to structures designed to the Uniform Building Code.

3. Munitions Damaged in "L" Warehouses. Event 3 addresses whether the earthquake causes an agent release from the stored munitions. Two failure modes are analyzed: puncture and crushing.

Only ton containers are subject to these failures. Spray tanks are in overpacks which protect them from crush forces. Furthermore, they are not stocked while in storage, hence cannot be punctured.

Three damage combinations are considered in Event 3:

a. No agent releases result from the earthquake (L = 0).

b. The earthquake causes an agent release in one warehouse (L = 1).

c. The earthquake causes an agent release in both warehouses (L = 2).

The puncture probability is the probability that at least one ton container falls and strikes a probe of sufficient size and density to penetrate it. The probability that ton containers are crushed is correlated to warehouse damage. If K is 0, 1, or 2 in Event 2, then ton containers in none, 1, or 2 warehouses are crushed, respectively. Since the NAAP site has only one warehouse, the probability that L = 2 is zero for that site. In addition, since only spray tanks are stored in the TEAD warehouses, L can only be zero at that site.

4. Ignition at "M" Warehouses. Seismically initiated fires are an important consideration because they influence agent dispersion and can thermally fail agent containers. This second

aspect is particularly important at TEAD because fire damage is the only spray tank container failure mode.

Electrical fires are the only concern in warehouses. The three conditions necessary for an electrical fire are:

a. An electrical fault capable of causing arcing.
b. A supply of electric power to sustain the arc.
c. Contact with an ignition source.

Including this second condition in the fire ignition probability calculation is important because available data indicate that offsite power can be lost at a relatively low seismic intensity.

Condition three considers both the agent and wood dunnage assemblies as possible ignition sources in the warehouses. If ton containers have been damaged by either crush or puncture, the probability of igniting spilled agent given an electrical arc has occurred is essentially unity. If no munition damage has occurred, the probability of ignition is represented as the ratio of exposed wood surface area to the total area of the warehouse.

Similar to previous events, Event 4 addresses how many warehouses experience ignition.

5. Ignition at Warehouse With Damaged Munitions. If the earthquake only damages the containers stored in one warehouse and ignition occurs at only one warehouse, it is necessary to discern whether the fire is in the warehouse with the damaged containers. If the fire is in the same warehouse as the damaged containers, thermal failure and the subsequent release of agent from the second warehouse is averted. However, if the

damaged containers and fire are in different warehouses, then the agent release source term will be increased.

Suppression of fires has a negligible probability since the warehouses have no fire alarms nor automatic fire suppression systems. For this reason it is not considered in the warehouse analysis.

5.2.5. Lightning

Munitions stored in igloos and warehouses are protected from lightning. Hence, only ton containers stored outdoors at APG, PBA, and TEAD may be susceptible to lightning strikes. No event tree model has been developed for this scenario. Basically, if sufficiently energetic lightning strikes a ton container, the container will be breached and agent will spill to the ground.

A lightning strike density for the contiguous United States was previously determined (Ref. 5-13) based on the correlation developed from the duration of thunderstorms. Based on this empirical correlation, the frequency (events/yr-km^2) for the different storage locations has been determined, as shown in Table 4-6.

Using conservative assumptions, a threshold lightning energy required to burn through the ton container wall was found to be proportional to the fourth power of the wall thickness as described in the calculation sheets (Ref. 5-2). Neglecting corrosion thinning of the container wall, the maximum value of failure frequency for each cluster of 15 ton containers at PBA is 5.1×10^{-10}, as shown in Table 5-12.

The results indicate that the threshold lightning energy required to burn through the container wall is a strong function of wall thickness. In order to assess the sensitivity of the failure frequency to

TABLE 5-12
SITE-SPECIFIC LIGHTING STRIKE INFORMATION

Name of Site	Ground Density [1] Event/Yr/km^2 N_1	Projected Area for Each Cluster (21 Container) (km)	Failure Probability Event/Yr-Cluster No Corrosion Effect	Failure Probability Event/Yr-Cluster Corrosion Effect
Aberdeen Proving Ground (APG)	3	2.5×10^{-3}	1.4×10^{-10}	7.65×10^{-9}
Anniston Army Deport (ANAD)	9	2.5×10^{-3}	--	
Laxington - Blue Grass Army Depot (LBAD)	9	2.5×10^{-3}	--	
Newport Army Ammunition Depot (NAAP)	5	2.5×10^{-3}	--	
Pine Bluff Arsenal (PBA)	11	2.5×10^{-3}	5.1×10^{-10}	2.8×10^{-8}
Pueblo Depot Activity (PUDA)	4	2.5×10^{-3}	--	
Tooele Army Deport (TEAD)	3	2.5×10^{-3}	1.4×10^{-10}	7.65×10^{-9}
Umatilla Depot Activity (UMDA)	2	2.5×10^{-3}	--	

corrosion, a probability density function for wall thickness was derived by conservatively assuming that one ton container stored outdoors has a leak through its wall. This is a conservative assumption since no wall leaks have been reported. This probability density function for wall thickness is used in conjunction with the lightning energy requirements to calculate the failure frequency of a cluster of 21 containers at the different sites. As expected for the PBA site, the failure probability is increased by approximately 55 from the previous value of 5.1×10^{-10}.

If all other agent release scenarios have frequencies that are below this bounding value, then the extent of container corrosion must be investigated. However, if other scenarios involving comparable or larger amounts of agent release also have frequencies much higher than the bounding value for the lightning initiated release, then lightning release scenarios can be ignored. This is true for aircraft crash accidents which lead to much larger releases and also higher frequencies for some sites.

5.2.6. Floods

During a flood, materials such as lumber, crates, storage tanks, and other lightweight containers may be carried away by flood flows and cause damage to downstream structures. Water velocities during floods depend largely on the size and shape of the cross sections, conditions of the stream, and the slope bed, all of which vary on different streams and at different locations. In the upper reaches of a flood basin, main channel flows could be as high as 14 ft/s, but typical overbank flow is less than 2 ft/s (Ref. 5-14).

Munitions stored in igloos and warehouses are considered protected against flood-generated projectiles. The only munition stored outdoors are mustard-filled ton containers (APG, PBA, and TEAD).

The puncture equation is as follows:

$$V_m^2 = \{64\ (672\ DT)^{3/2}\}/W \quad , \tag{5-4}$$

where D = probe diameter (in.),
T = wall thickness to be punctured (in.),
W = weight of projectile (i.e., moving object) (lb),
V_m = velocity of projectile (ft/s).

The wall thickness of the ton container is 0.41 in. Assuming the smallest probe size is 0.8-in. in diameter,

$$V_m^2\ (W) = (64)(672\ DT)^{3/2} = 217{,}335$$

For puncture, the following conditions must be met:

V_m (ft/s)	W (lb)
1	217,335
2	53,334
6	6,037
10	2,173
14	1,108

A credible flood-generated projectile is assumed to be a light, steel tank with a rigidly attached 0.8-in. diameter probe. This could be a water storage tank or a gasoline tank, using a tank height to diameter ratio of 1.2 and a wall thickness of 0.25 in. Table 5-13 presents the data developed for steel tanks. Tanks larger than 10 ft in diameter would not be credible except in main channel flows. Thus, typical overbank flows, i.e., 2 ft/s, would not produce puncture.

TABLE 5-13
PROBABLE SIZE DISTRIBUTION FOR STEEL TANKS

D Diameter (ft)	1.2D Height (ft)	$57.67D^2$ Weight (lb)	$5.3407D^2$ Surface Area (ft^2)
2	2.4	231	21.36
4	4.8	923	84.45
6	7.2	2076	192.0
8	9.6	3690	342.0
10	12.0	5767	534.0

Puncture could be initiated by using an extreme overbank velocity of 6.13 ft/s combined with a 10-ft diameter floating tank with a rigidly attached 0.8-in. probe. The probability of a 6.13 ft/s overbank velocity is estimated to be less than 10%. This condition will be designated as the reference flood-generated projectile.

The probability of puncture of a single ton container from the reference single floating tank condition is as follows:

$$P_F = L_p \times T_p \times P_p \quad , \tag{5-5}$$

where L_p = location probability, i.e., the probability that the probe attached to the floating tank is pointing towards the ton container wall at the moment of collision,

T_p = target probability, i.e., the probability that the tank collides with the ton container,

P_p = probability of probe being present.

L_p can be approximated by the ratio of total surface area to the effective surface position. Assuming that the probe must be within a 1 ft^2 location, then:

$$L_p = 1/(7.06)^2\ (5.3407) = 0.0038 \quad .$$

T_p can be approximated by assuming a flood channel width at the point of collision and comparing that to the length of a ton container (82 in.). Using a three-mile wide channel, which is conservative for a typical flood, then:

$$T_p = 82/\{(5280)\ (12)\ (3)\} = 0.00043 \text{ or } 0.0043$$

for the total width of 10 containers.

P_p is estimated to be 1×10^{-3}. Thus the probability of a reference tank hitting and rupturing a ton container is

$$P_F = (0.0038)\ (0.0043)\ (0.001) = 1.6 \times 10^{-8} \quad .$$

It would seem reasonable from the flood basin size to assume no more than one reference floating projectile per flood and the flood reoccurrence to be greater than 100 years. In addition, the probability of a 6 ft/s overbank velocity is estimated as 10%. Thus, the probability of rupture is approximately 1.63×10^{-11}/yr.

Thus, based on the above calculations this sequence can be screened out on the basis that its frequency is below the screening criterion.

5.3. SPECIAL HANDLING ACTIVITIES

5.3.1. Leaking Munitions

Several scenarios were identified that specifically address the leakage of stored munitions and the accidents that could occur in the process of isolating leaking munitions which could aggravate the existing situation. The event trees are shown in Figs. 5-7 and 5-8.

Sequence SL1 addresses the possibility that a munition could leak from the time the periodic inspection has been performed until the next periodic inspection. It is assumed that the leaking munition will be detected at the time the next inspection is made. For all sites, except at APG, the inspections are assumed to be performed quarterly (90 days). At APG, the ton containers are inspected daily. No event tree was developed for this scenario since it is represented by a single event failure.

Sequences SL2 and SL9 address accidents related to the movements of munitions for inspection or isolation of leakers. The forklift tine puncture or drop of munition was determined to be largely due to human error. The quantification of these events required a detailed human reliability study (Ref. 5-15). Essentially a task analysis was performed to identify those errors that could potentially impact agent release probabilities. Available data was used to quantify the probabilities of some of these errors and extrapolations were made from these fixed data to quantify the remainder.

Isolation of leaking rockets require special tasks. The leaking rockets are isolated in the storage igloo at the original location, where the pallet containing the leaking rocket is unpacked. Only those rockets blocking access to the leaking rocket are removed and are placed in a holding fixture. This rocket is hand-carried by a two-man team wearing Level A protective clothing to the PIG (which has been placed

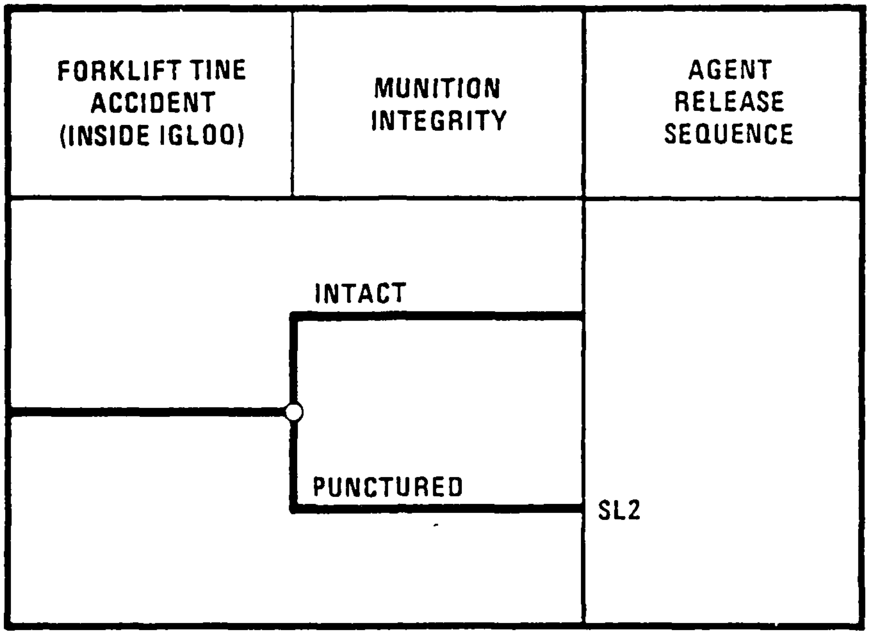


Fig. 5-7. Munition punctured by forklift tine during leaker - handling activities

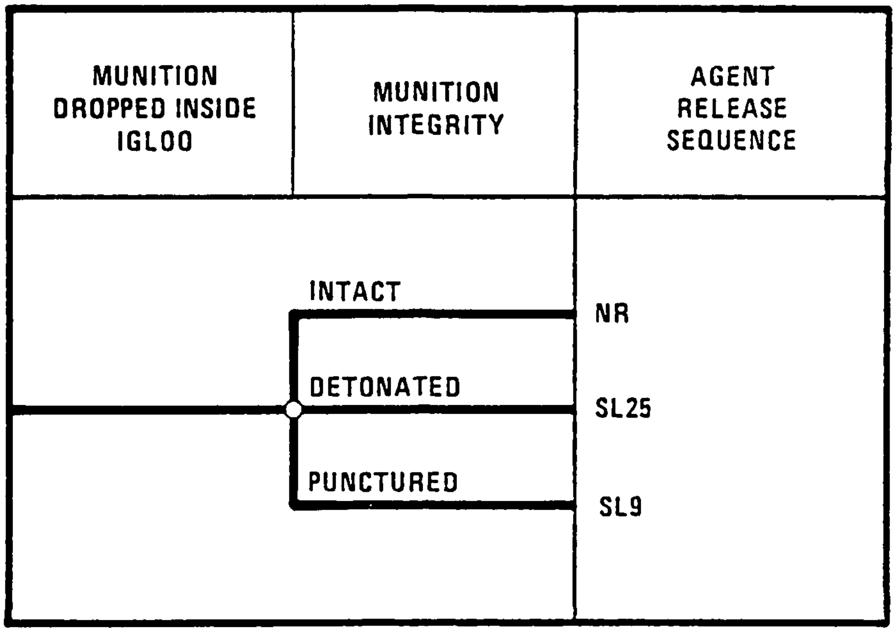
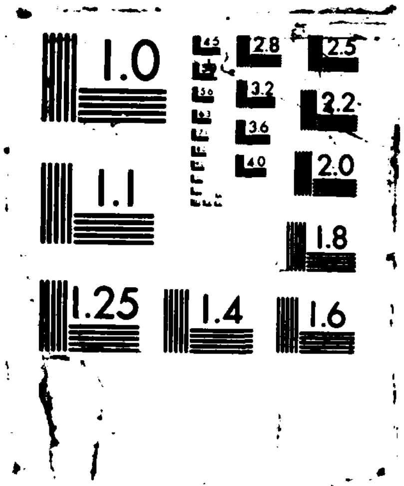


Fig. 5-8. Munition dropped during leaker isolation operation

AD-A193 354 CHEMICAL STOCKPILE DISPOSAL PROGRAM RISK ANALYSIS OF THE ONSITE DISPOSAL O..(U) GA TECHNOLOGIES INC SAN DIEGO CA A W BARSELL ET AL. AUG 87 GA-C-18562 3/9

UNCLASSIFIED SAPEO-CDE-IS-87010 DAAA15-85-D-0022 F/G 15/6.3 NL


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

on a plastic sheet) and secured in it. The handlers lift the decontaminated PIG by its handles, carry it outside, and place it on the truck that will carry it to an igloo reserved for leaking munitions (Ref. 5-1). The analysis assumes that the same procedure is followed for isolating other leaking munitions, except that overpacks (other than PIGs) are used.

Three types of operator errors related to leaker isolation were identified in the task analysis: (1) puncturing a munition with a forklift tine, (2) dropping a munition or pallet from a forklift, and (3) dropping a single munition while hand-carrying it. Details on these handling errors are discussed in Section 6 (Handling Activities).

Table 5-14 presents the data used to evaluate the accident frequencies for the scenarios addressed above. The frequency of scenario SL1 was derived by determining the leakage rate for each munition type based on the leaker data at each site and the total munition inventory at each site. Since the two parameters are classified information, they will be presented and discussed further in a classified appendix.

TABLE 5-14
DATA BASE FOR ANALYSIS OF SEQUENCES SL1, SL2, AND SL9

Event	Frequency or Probability	Reference
Munition develops a leak during storage (Scenario SL1):		
Bomb (TEAD)	7.5E-5 per year	Ref. 5-16
(UMDA)	4.5E-4 per year	
4.2-in. mortar (ANAD)	2.8E-7 per year	
(PUDA)	1.0E-6 per year	
(TEAD)	7.0E-6 per year	
105-mm cartridge (ANAD)	2.8E-7 per year	
(PUDA)	1.0E-6 per year	
(TEAD)	7.0E-6 per year	
Ton container		
Mine (ANAD)	9.0E-6 per year	
(PBA)	1.1E-6 per year	
(TEAD)	2.5E-4 per year	
(UMDA)	3.1E-4 per year	
Projectile (ANAD)	4.9E-6 per year	
(LBAD)	9.3E-6 per year	
(PUDA)	5.0E-6 per year	
(TEAD)	8.1E-5 per year	
(UMDA)	6.2E-5 per year	
Rocket (ANAD)	6.1E-5 per year	
(LBAD)	4.3E-5 per year	
(PBA)	9.1E-7 per year	
(TEAD)	1.3E-3 per year	
(UMDA)	1.8E-4 per year	
Spray tank	9.8E-5 per year	
Forklift tine accident (SL2)	1.0E-4 per operator	Ref. 5-17
Munition puncture given tine accident:		
Bomb	1.29E-2	Ref. 5-2
4.2-in. mortar	3.68E-2	
105-mm cartridge	8.90E-3	
Mine	7.07E-2	

TABLE 5-14 (Continued)

Event	Frequency or Probability	Reference
Projectile	5.00E-2	
Rocket	2.63E-1	
Spray tank	1.53E-2	
Munition dropped during leaker isolation (SL9):		
Pallet and bulk (B, S)	3.0E-4	Human Reliability
Single (C, D, M, P, Q, R)	6.0E-4	Analysis (Ref. 5-17)
Ton container (K)	3.0E-5	
Munition punctured given drop:		
Bomb (pallet)	4.72E-4	Ref. 5-2
(single)	1.62E-4	
4.2-in. mortar (pallet)	1.24E-4	
(single)	0.0	
105-mm cartridge (pallet)	2.71E-5	
(single)	0.0	
Ton container	1.55E-3	
Mine (pallet)	9.27E-5	
(single)	4.08E-5	
Projectile (pallet or single)	0.0	
Munition detonates given 6 ft drop	1.6E-8/munition	Ref. 5-2

5.4. SCENARIO QUANTIFICATION

Tables 5-15 and 5-16 present the results of the accident scenario frequency analysis for all the storage sequences discussed previously except those which were initially screened (i.e., SL10, SL11, SL12, SL13, and SL14). From the results it is evident that the following sequences could be screened out further based on the 1.0×10^{-10}/yr criterion:

SL17 - Large aircraft direct crash; fire contained in 30 min.

SL21 - Large aircraft indirect crash; fire contained in 30 min.

SL23 - Tornado-generated missiles cause munition detonation upon impact.

Since handling-related accidents are given in terms of events per munition operation, no screening can be performed without divulging classified information.

The trends indicated by the frequency results are as follows:

<u>Externally-Induced Events</u>

1. Tornado and high wind

    a. Munitions stored outdoors or in warehouses are generally more susceptible to tornado strikes. APG, PBA, NAAP, TEAD, and UMDA have warehouses. PBA and NAAP are in Tornado Zone I while APG is in Tornado Zone II (Zone I has the highest tornado frequency). TEAD and UMDA are in Tornado Zone III.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SL1 - Munition develops a leak during the between-inspections period.																	
SLBGC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.5E-05	1.0E+01	4.5E-04	1.0E+01
SLDHC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-06	1.0E+01	7.0E-06	1.0E+01	N/A	-
SLCGC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.0E-06	1.0E+01	N/A	-
SLCHC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-06	1.0E+01	N/A	-	N/A	-
SLKGC (IGL)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-04	1.0E+01	N/A	-
SLKHC (60' IGL)	1	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	1	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-	5.9E-06	1.0E+01	N/A	-
SLKHS (OPEN)	1	N/A	-	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHC (NH)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01
SLKVC (80' IGL)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-
SLKVC (NH)	1	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	1	9.0E-06	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-06	1.0E+01	N/A	-	2.5E-04	1.0E+01	3.1E-04	1.0E+01
SLPGC	1	4.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01
SLPHC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	5.0E-06	1.0E+01	8.1E-05	1.0E+01	N/A	-
SLPVC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01
SLQGC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01
SLQVC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01
SLRGC	1	6.1E-05	1.0E+01	N/A	-	4.3E-05	1.0E+01	N/A	-	9.1E-07	1.0E+01	N/A	-	1.3E-03	1.0E+01	1.8E-04	1.0E+01
SLRVC	1	6.1E-05	1.0E+01	N/A	-	4.3E-05	1.0E+01	N/A	-	9.1E-07	1.0E+01	N/A	-	1.3E-03	1.0E+01	1.8E-04	1.0E+01
SLSVC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-05	1.0E+01
SLSVC (NH)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-05	1.0E+01	N/A	-
SL2 - Munition punctured by forklift tine during leaker handling activities.																	
SLBGC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.2E-06	1.3E+01	5.2E-06	1.3E+01
SLDHC	2	4.4E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-05	1.3E+01	4.4E-05	1.3E+01	N/A	-
SLCGC	2	1.1E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-
SLCHC	2	1.1E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-	N/A	-
SL[illegible]GC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLKHC	2	0.0E+00	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	0.0E+00	-
SLKVC	2	N/A	-	N/A		N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLMVC	2	8.5E-05	1.3E+01	N/A	-	N/A	-	N/A	-	8.5E-05	1.3E+01	N/A	-	8.5E-05	1.3E+01	8.5E-05	1.3E+01
SLFGC	2	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01
SLFHC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	N/A	-
SLFVC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01
SLGGC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01
SLGVC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01
SLRGC	2	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	3.2E-04	1.3E+01
SLRVC	2	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	3.2E-04	1.3E+01
SLSVC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.6E-06	1.3E+01	4.6E-06	1.3E+01
SL4 - Large aircraft direct crash onto storage area; fire not contained in 30 minutes (burstered munitions detonate if hit).																	
SLBGF (80 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.6E-12	1.0E+01	4.1E-10	1.0E+01
SLBGF (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLDHC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLDHC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	-
SLDHC (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLCGC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCGC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	-	N/A	-
SLCGC (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	-	N/A	-
SLCHC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCHC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	N/A	1.0E+01	N/A	-
SLCHC (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.0E+01	N/A	-
SLKGF (80 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	N/A	
SLKHF (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHF (OPEN)	4	N/A	-	1.1E-09	1.0E+01	N/A	-	N/A	-	7.6E-09	1.0E+01	N/A	-	3.5E-09	1.0E+01	N/A	
SLKHI (WH)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-08	1.0E+01
SLKVF (80 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	N/A	

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLKVF (MH)	4	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLPGC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPGC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLPGC (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLPHC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPHC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	-
SLPHC (89 IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLPVC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPVC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLPVC (89 IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLQGC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQGC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLQGC (89 IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLQVC (60 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQVC (80 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLQVC (89 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLRGC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRGC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLRGC (89 IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLRVC (60 IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRVC (80 IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01
SLRVC (89 IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-
SLSVF (80 IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.1E-10	1.0E+01
SLSVF (MH)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.9E-10	1.0E+01	N/A	
SL5 - Large aircraft indirect crash onto storage area; fire not contained in 30 minutes (burstered munitions detonate if hit).																	
SL5GF (60 IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
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Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLBGF (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLDHC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLDHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	2.7E-12	1.3E+01	N/A	-
SLDHC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLCGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	-	N/A	-
SLCGC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	-	N/A	-
SLCHC (60 IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	N/A	1.3E+01	N/A	-
SLCHC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.3E+01	N/A	-
SLKGF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1 3E+01	N/A	-
SLKHF (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHF (OPEN)	5	N/A	-	2.1E-09	1.0E+01	N/A	-	N/A	-	7.9E-09	1.0E+01	N/A	-	2.7E-12	1.0E+01	N/A	-
SLKHF (MH)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-08	1.1E+01
SLKVF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLKVF (MH)	5	N/A	-	N/A	-	N/A	-	3.8E-09	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLPGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLPGC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLPHC (60 IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	2.7E-12	1.3E+01	N/A	-
SLPHC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLPVC (60 IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLPVC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLQGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLQGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLQGC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLQVC (60' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQVC (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLQVC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLRGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLRGC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLRVC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01
SLRVC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-
SLSVF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-10	1.3E+01
SLSVF (NH)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.0E-10	1.1E+01	N/A	-
SL6 - Tornado generated missiles strike the storage magazine, warehouse, or open storage area; munitions breached (no detonation).																	
SLBGC	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.5E-15	9.4E+01	1.2E-15	9.4E+01
SLDHC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-13	9.4E+01	5.8E-15	9.4E+01	N/A	-
SLCGC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	N/A	-
SLCHC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-13	9.4E+01	N/A	-	N/A	-
SLKGC (80' IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.4E-15	9.4E+01	N/A	-
SLKHC (60' IGL)	6	1.2E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	6	N/A	-	6.6E-11	9.4E+01	N/A	-	N/A	-	9.9E-10	9.4E+01	N/A	-	1.2E-12	9.4E+01	N/A	-
SLKHC (NH)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.9E-13	9.4E+01
SLKVC (80' IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.4E-15	9.4E+01	N/A	-
SLKVC (NH)	6	N/A	-	N/A	-	N/A	-	3.3E-10	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	8.3E-12	9.4E+01	N/A	-	1.3E-14	9.4E+01	5.8E-15	9.4E+01
SLPGC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01
SLPHC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	3.2E-13	9.4E+01	5.8E-15	9.4E+01	N/A	-
SLPVC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLQGC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01
SLQVC	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01
SLRGC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	1.9E-11	9.4E+01	N/A	-	4.8E-14	9.4E+01	5.8E-15	9.4E+01
SLRVC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	1.9E-11	9.4E+01	N/A	-	4.8E-14	9.4E+01	5.8E-15	9.4E+01
SLSVC (80' IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.5E-15	9.4E+01
SLSVC (MH)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-13	9.4E+01	N/A	-
SL7 - Severe earthquake breaches the munitions in storage igloo; no detonations.																	
SLBGC	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-06	1.3E+01	7.0E-08	1.3E+01
SLDHC	7	3.0E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-08	1.3E+01	7.0E-07	1.3E+01	N/A	-
SLCGC	7	7.0E-09	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-07	1.3E+01	N/A	-
SLCHC	7	7.0E-09	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	7.0E-09	1.3E+01	N/A	-	N/A	-
SLKGC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-
SLKHC (60' IGL)	7	4.6E-07	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	7	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-
SLKHC (MH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKVC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-
SLKVC (MH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	7	1.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	1.8E-08	1.3E+01	N/A	-	4.1E-07	1.3E+01	1.8E-08	1.3E+01
SLPGC	7	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLPHC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	N/A	-
SLPVC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLQGC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLQVC	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLRGC	7	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	2.1E-06	1.3E+01	9.7E-08	1.3E+01
SLRVC	7	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	2.1E-06	1.3E+01	9.7E-08	1.3E+01
SLSVC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLSVC (MH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SL8 Meteorite strikes the storage area; fire occurs; munitions breached (if burstered detonation occurs)																	

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLBGF	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLDHC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	N/A	-
SLCGC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-
SLCHC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-
SLKGF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-
SLKHF (IGL)	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHF (OPEN)	8	N/A	-	1.2E-11	1.7E+01	N/A	-	N/A	-	1.2E-11	1.7E+01	N/A	-	1.2E-11	1.7E+01	N/A	-
SLKHF (WH)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-10	2.6E+01
SLKVF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-
SLKVF (WH)	8	N/A	-	N/A	-	N/A	-	1.0E-09	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLPGC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLPHC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	N/A	-
SLPVC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLQGC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLQVC	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLRGC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLRVC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01
SLSVF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01
SLSVF (WH)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-09	2.6E+01	N/A	-
SL9 - Munition dropped during leaker isolation activities.																	
SLBGC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.6E-07	1.3E+01	6.6E-07	1.3E+01
SLDHC	9	4.5E-07	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.5E-07	1.3E+01	4.5E-07	1.3E+01	N/A	-
SLCGC	9	9.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-08	1.3E+01	N/A	-
SLCHC	9	9.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-08	1.3E+01	N/A	-	N/A	-
SLKGC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-
SLKHC	9	1.9E-07	1.3E+01	1.9E-07	1.3E+01	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	1.9E-07	1.3E+01	1.9E-07	1.3E+01
SLKVC	9	N/A	-	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLMVC	9	3.6E-07	1.3E+01	N/A	-	N/A	-	N/A	-	3.6E-07	1.3E+01	N/A	-	3.6E-07	1.3E+01	3.6E-07	1.3E+01
SLPGC	9	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLFHC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	N/A	-
SLFVC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLGBC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLGVC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLRGC	9	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	1.5E-06	1.3E+01
SLRVC	9	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	1.5E-06	1.3E+01
SLSVC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.6E-06	1.3E+01	3.6E-06	1.3E+01
SL15 - Small aircraft direct crash onto warehouse or open storage yard; fire not contained in 30 minutes.																	
SLFGF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLFHF (IGL)	15	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLFHF (OPEN)	15	N/A	-	1.6E-05	1.0E+01	N/A	-	N/A	-	5.6E-07	1.0E+01	N/A	-	1.4E-07	1.0E+01	N/A	-
SLFHF (WH)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-09	1.0E+01
SLFVF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLFVF (WH)	15	N/A	-	N/A	-	N/A	-	8.1E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLSVF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLSVF (WH)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-08	1.0E+01	N/A	-
SL16 - Large aircraft direct crash; no fire. (burstered munitions detonate)																	
SLGBC (80 IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLGGC (89 IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLDHC (50 IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLDHC (80 IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	-
SLDHC (89 IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLCGC (50 IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	
SLCGC (80 IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	-	N/A	-
SLCGC (89 IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	-	N/A	-
SLCHC (80 IGL)	16	2.0E-10	1.0E+01	N/A		N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLCHC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	N/A	1.0E+01	N/A	-
SLCHC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.0E+01	N/A	-
SLKGC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	N/A	-
SLKHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	16	N/A	-	1.3E-09	1.0E+01	N/A	-	N/A	-	9.4E-09	1.0E+01	N/A	-	4.3E-09	1.0E+01	N/A	-
SLKHS (WH)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-08	1.0E+01
SLKVC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	N/A	-
SLKVS (WH)	16	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLPGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLPGC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLPHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPHC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	-
SLPHC (89' IGL)	16	N/A	-	N/A	-	N/A	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLPVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLPVC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLQGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLQGC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLQVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLQVC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLRGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLRGC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLRVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01
SLRVC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-
SLSVC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.0E-10	1.0E+01
SLSVS (WH)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.8E-10	1.0E+01	N/A	-
SL17 - large aircraft direct crash; fire contained within 30 minutes. (Applies to non-burstered munitions only)																	
SLKHF (OPEN)	17	N/A	-	3.7E-13	1.0E+01	N/A	-	N/A	-	2.6E-12	1.0E+01	N/A	-	1.2E-12	1.0E+01	N/A	-
SLKHF (WH)	17	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.8E-12	1.0E+01
SLKVF (WH)	17	N/A	-	N/A	-	N/A	-	5.6E-13	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLSVF (WH)	17	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-13	1.0E+01	N/A	-
SL18 - Small aircraft direct crash onto warehouse or open storage yard; no fire.																	
SLKHS (OPEN)	18	N/A	-	2.0E-05	1.0E+01	N/A	-	N/A	-	6.9E-07	1.0E+01	N/A	-	1.7E-07	1.0E+01	N/A	-
SLKHS (WH)	18	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-08	1.0E+01
SLKVS (WH)	18	N/A	-	N/A	-	N/A	-	1.0E-08	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLSVS (WH)	18	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-08	1.0E+01	N/A	-
SL19 - Small aircraft direct crash onto warehouse or open storage yard; fire contained in 30 minutes.																	
SLKHF (OPEN)	19	N/A	-	3.0E-07	1.3E+01	N/A	-	N/A	-	1.1E-08	1.3E+01	N/A	-	2.7E-09	1.3E+01	N/A	-
SLKHF (WH)	19	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-10	1.3E+01
SLKVF (WH)	19	N/A	-	N/A	-	N/A	-	1.5E-10	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLSVF (WH)	19	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-10	1.3E+01	N/A	-
SL20 - Large aircraft indirect crash onto storage area; no fire.																	
SLBGC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLBGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLDHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLDHC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	3.3E-12	1.3E+01	N/A	-
SLDHC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLCGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	-	N/A	-

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLCGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	-	N/A	-
SLCHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLCHC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	N/A	1.3E+01	N/A	-
SLCHC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.3E+01	N/A	-
SLKGC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	N/A	-
SLKHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	20	N/A	-	2.6E-09	1.0E+01	N/A	-	N/A	-	9.7E-09	1.0E+01	N/A	-	3.5E-09	1.0E+01	N/A	-
SLKHC (MH)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-08	1.1E+01
SLKVC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	N/A	-
SLKVC (MH)	20	N/A	-	N/A	-	N/A	-	4.7E-09	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLPGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLPGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLPHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPHC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	3.3E-12	1.3E+01	N/A	-
SLPHC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLPVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLPVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLPVC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLQGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLQGC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLQVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLQVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLQVC (89' IGL)	20	N/A		N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLRGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLRGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLRGC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLRVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLRVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01
SLRVC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-
SLSVC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-10	1.3E+01
SLSVC (WH)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.4E-10	1.1E+01	N/A	-
SL21 - large aircraft indirect crash onto storage area; fire contained in 30 minutes																	
SLBGF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	-	0.0E+00	-
SLBGF (89' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.3E-16	-	N/A	-
SLKGF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	-	N/A	-
SLKHF (60' IGL)	21	1.9E-14	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHF (OPEN)	21	N/A	-	7.2E-13	1.0E+01	N/A	-	N/A	-	2.7E-12	1.0E+01	N/A	-	9.7E-13	1.0E+01	N/A	-
SLKHF (WH)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.8E-12	1.1E+01
SLKVF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	1.3E+01	N/A	-
SLKVF (WH)	21	N/A	-	N/A	-	N/A	-	1.3E-12	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-
SLSVF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-
SLSVF (WH)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.1E-13	1.1E+01	N/A	-
SL22 - Severe earthquake leads to munition detonation																	
SLBGC	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLDHC	22	1.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-08	2.6E+01	2.7E-07	2.6E+01	N/A	-
SLCGC	22	6.2E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-07	2.6E+01	N/A	-
SLCHC	22	6.2E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.2E-07	2.6E+01	N/A	-	N/A	-
SLKGS (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLKHS (IGL)	22	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	22	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-
SLKHS (WH)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-
SLKVS (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLKVS (WH)	22	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	22	7.0E-09	2.6E+01	N/A	-	N/A	-	N/A	-	7.0E-09	2.6E+01	N/A	-	1.6E-07	2.6E+01	7.0E-09	2.6E+01
SLPGC	22	4.7E-09	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-07	2.6E+01	4.7E-09	2.6E+01
SLPHC	22	4.7E-09	2.6E+01	N/A	-	4.7E-09	2.6E+01	N/A	-	N/A	-	4.7E-09	2.6E+01	1.0E-07	2.6E+01	N/A	-
SLPVC	22	4.7E-09	2.6E+01	N/A	-	4.7E-09	2.6E+01	N/A	-	N/A	-	N/A	-	1.0E-07	2.6E+01	4.7E-09	2.6E+01
SLQGC	22	3.4E-09	2.6E+01	N/A	-	3.4E-09	2.6E+01	N/A	-	N/A	-	N/A	-	7.6E-08	2.6E+01	3.4E-09	2.6E+01
SLQVC	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.6E-08	2.6E+01	3.4E-09	2.6E+01
SLRGC	22	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	8.9E-08	2.6E+01	3.9E-09	2.6E+01
SLRVC	22	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	8.9E-08	2.6E+01	3.9E-09	2.6E+01
SLSVF (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-
SLSVF (WH)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SL23 - Tornado generated missiles strike the storage igloo and cause munition detonation.																	
SLBGS	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLDHC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.2E-14	9.9E+01	3.2E-16	9.9E+01	N/A	-
SLCGC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	N/A	-
SLCHC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.2E-14	9.9E+01	N/A	-	N/A	-
SLKGS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLKHS (IGL)	23	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-
SLKHS (OPEN)	23	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-
SLKHS (WH)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-
SLKVS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLKVS (WH)	23	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-
SLMVC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	4.6E-13	9.9E+01	N/A	-	7.4E-16	9.9E+01	4.0E-16	9.9E+01
SLPGC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01
SLPHC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	2.2E-14	9.9E+01	3.2E-16	9.9E+01	N/A	-
SLPVC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01
SLQGC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01
SLQVC	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLRGC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	1.1E-12	9.9E+01	N/A	-	2.6E-15	9.9E+01	4.0E-16	9.9E+01
SLRVC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	1.1E-12	9.9E+01	N/A	-	2.6E-15	9.9E+01	4.0E-16	9.9E+01
SLSVS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-
SLSVS (WH)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SL24 - Lightning strikes ton containers stored outdoors.																	
SLKHS (OPEN)	24	N/A	-	1.4E-10	1.0E+01	N/A	-	N/A	-	5.1E-10	1.0E+01	N/A	-	1.4E-10	1.0E+01	N/A	-
SL25 - Munitions dropped during leaker isolation; munition detonates.																	
SLBGC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLDHC	25	1.7E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-07	2.6E+01	1.7E-07	2.6E+01	N/A	-
SLCGC	25	8.9E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-08	2.6E+01	N/A	-
SLCHC	25	8.9E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-08	2.6E+01	N/A	-	N/A	-
SLKGC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLKHC	25	0.0E+00	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-
SLKVC	25	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-
SLMVC	25	1.3E-07	2.6E+01	N/A	-	N/A	-	N/A	-	1.3E-07	2.6E+01	N/A	-	1.3E-07	2.6E+01	1.3E-07	2.6E+01
SLPGC	25	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01
SLPHC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	N/A	-
SLPVC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01
SLQGC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01
SLQVC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01
SLRGC	25	5.7E-06	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	5.7E-08	2.6E+01
SLRVC	25	5.7E-06	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-06	2.6E+01	5.7E-08	2.6E+01
SLSVC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-

NOTES:

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR

1. Frequency units for scenario 1 are events per munition year.

2. Frequency units for scenarios 2, 9, and 25 are events per leaker.

3. Frequency units for scenarios 4, 5, 8, 15 through 21, and 23 are events per storage unit-year (igloo or warehouse). For ton containers stored outdoors, frequency units for scenarios 8 and 24 are events per cluster-year of ton containers (15 TC/cluster).

4. Agent release for SLKHS 1 (open) assumes outdoor spill onto a porous surface.

5. Frequency units for scenarios 7 and 22 are events per year.

TABLE 5-16
FREQUENCY OF EARTHQUAKE STORAGE ACCIDENTS PER YEAR
(STORAGE AT EXISTING SITES)

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STORAGE EARTHQUAKE - WAREHOUSES

STORAGE - EARTHQUAKE-INDUCED ACCIDENTS IN THE WAREHOUSES
(PER YEAR)

ACCIDENT FREQUENCIES

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLKVF	261	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-06	1.0E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SLKVC	262	N/A	N/A	N/A	N/A	N/A	N/A	9.5E-07	2.0E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SLKVF	263	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-09	2.9E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SLKVF	264	N/A	N/A	N/A	N/A	N/A	N/A	3.3E-04	5.5E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SLKVC	265	N/A	N/A	N/A	N/A	N/A	N/A	1.4E-04	8.6E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SLSVF	271	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.7E-04	8.6E+00	N/A	N/A
SLSVF	272	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.3E-06	7.1E+00	N/A	N/A
SLSVF	273	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-05	9.3E+00	N/A	N/A
SLSVF	274	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9E-06	1.1E+01	N/A	N/A
SLSVF	275	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.0E-07	3.4E+01	N/A	N/A
SLSVF	276	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.8E-08	2.8E+01	N/A	N/A
SLKHF	281	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.8E-07	1.2E+01
SLKHF	282	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.3E-05	8.8E+00
SLKHF	283	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9E-07	1.8E+01
SLKHC	284	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-10	3.1E+01
SLKHF	285	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-10	3.1E+01
SLKHF	286	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL	
SLKHF	287	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.5E-10	5.8E+01
SLKHC	288	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL	
SLKHF	289	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL	
SLKHF	2810	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.4E-05	1.2E+01
SLKHF	2811	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.9E-05	7.5E+00
SLKHF	2812	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.2E-07	9.2E+[illegible]
SLKHF	2813	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.6E-08	2.3E+01
SLKHF	2814	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.9E-08	2.7E+01

TABLE 5-16 (Continued)

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STORAGE EARTHQUAKE - WAREHOUSES

STORAGE - EARTHQUAKE-INDUCED ACCIDENTS IN THE WAREHOUSES
(PER YEAR)

ACCIDENT FREQUENCIES

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
SLFHF	2815	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.6E-10	2.7E+01
SLFHF	2816	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.6E-05	5.2E+00
SLFHF	2817	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-05	9.6E+00

2. Meteorite strike

   a. Munitions stored in warehouses are more susceptible to meteorite strikes. Since fire is generally present, a meteorite strike may involve the entire warehouse inventory.

3. Aircraft crashes

   a. Munitions stored outdoors are generally more susceptible to these events than those stored indoors. APG, PBA, and TEAD have ton containers stored outdoors and the aircraft crash probabilities at these sites are relatively high compared to the other sites.

   b. Igloos provide minimal protection from direct crashes of large aircraft. The accident becomes more serious when burstered munitions are involved.

   c. Large aircraft crash frequencies at APG, LBAD, and TEAD greatly increase for the air option because of the additional landings and takeoffs at these sites.

4. Earthquakes

   a. Earthquakes, particularly in high seismic locations such as TEAD, could cause stacked munitions to be punctured. However, the probability of having a probe present inside an igloo is quite low.

   b. Detonations due to earthquake-induced drops are at least two orders of magnitude less likely than punctures.

c. There is a significantly high frequency earthquake-induced agent releases to munitions stored in warehouses at NAAP, TEAD, and UMDA.

Leaker-Related Events

1. Forklift drop accidents can occur more frequently than forklift time punctures.

2. Use of a lifting beam instead of a tine leads to an order of magnitude decrease in drop frequency.

5.5. UNCERTAINTY ANALYSIS

5.5.1. Overview

The frequency results presented in Tables 5-15 and 5-16 are median values. The values shown in the range factor column represent the ratios of the 95^{th} percentile values to the median values. The range factors vary from 10 to almost 100. The tornado frequency results have the highest uncertainties, largely because of the difficulty to accurately model the probability that the missile will be in the proper orientation to penetrate the munition and how many missiles per square foot of wind will actually be present. The ability to model low-impact detonations also leads to large uncertainties in the final results. The data available are scarce and sometimes not directly applicable to the scenario being analyzed.

5.5.2. Error Factors

In those cases where sufficient information exists to determine the upper and lower bound values, the error factor was derived by assuming that the upper bound value is equivalent to the 95^{th} percentile. The engineers' best estimate is taken as the median value based on the properties of the lognormal distribution. This choice is rather conservative, since the mean value of the resulting distribution becomes larger than the best estimate or recommended value.

In many cases, however, the data sources were limited. Therefore, the assignment of error factors was entirely based on engineering judgment, taking into consideration the important parameters which may influence a particular variable. The generic guidelines for the uncertainty assessment is shown in Table 5-17.

5.5.2.1. Tornado Sequence Uncertainties. The frequency of the initiating event itself (i.e., tornado wind of sufficient intensity to

TABLE 5-17
GENERIC UNCERTAINTY MODELS

- External events (both from natural causes and human-caused events external to the operation, e.g., aircraft crash): EF = 10.

- Component or equipment failure rates were generally assigned an error factor of 3. An exception to this rule is when the analyst does not feel confident with the applicability of the data to a particular demil equipment, component, or operation. In such case, a larger error factor was used, ranging from 5 to 10.

- In cases where the event probability range from 0.1 to 0.9, and was derived largely from engineering judgment, the error factor used is:

Probability:	0.1 to 0.3	EF = 2.0
Probability:	0.4 to 0.6	EF = 1.5
Probability:	0.7 to 0.8	EF = 1.4
Probability:	0.9	EF = 1.0

- Munition failure probability due to puncture that was calculated using standard mathematical models was assigned an error factor of 5.

generate missiles occurs) is assigned an error factor of 10, per Table 5-17. The conditional probability of a missile's hitting the structure and penetrating the munition is assigned an error factor of 50. As explained in Section 5.2.1.1 (Eq. 5-2), this event is the product of four variables. The uncertainty is largely due to the variable D_e which is the number of missiles per square foot of wind. The conditional probability of a burstered munition's detonating when hit by a missile is assigned an error factor of 2.

5.5.2.2. Meteorite Strike Sequence Uncertainty. The frequency of a meteorite strike is assigned an error factor of 10. The conditional probability of a meteorite's penetrating and rupturing the munition is the product of (1) fraction of stone and iron meteorites capable of penetrating the target; (2) target area; and (3) spacing factor. This event is assigned an error factor of 10. The uncertainty is largely due to the fraction of stone and iron meteorites capable of penetrating the structure.

5.5.2.3. Aircraft Crash Sequence Uncertainties. The aircraft crash frequency is assigned an error factor of 10. Aircraft crash accident sequences with or without fires (from impact) have been considered. For this reason no uncertainties were assigned to either the probability of having a fire (0.45) or no fire (0.55). The uncertainties associated with the structural damage (i.e., igloo or warehouse) given an aircraft crash are given in Table 5-9. For events with probabilities greater than 0.1, the uncertainties assigned followed the guidelines given in Table 5-17.

5.5.2.4. Earthquake Sequence Uncertainties

Storage Igloos

The initiating event, earthquake occurs, is assigned an error factor of 10. The conditional event, munition punctured given a

drop, is assigned an error factor of 5. The puncture probability is a function of drop height, weight and pressure of a probe of sufficient length and density. The uncertainty is largely due to the last variable. Note also that no uncertainty from errors with the models has been considered, since this is beyond the state-of-the-art of present-day uncertainty analysis.

Warehouse Storage

Event 1: Earthquake Occurs

The initiating event frequency is assigned an error factor of 10.

Event 2: "K" Warehouses Damaged by Earthquake

Uncertainty factors for values above 0.1 are taken from Table 5-17. For probabilities between 0.01 and 0.1, an uncertainty factor of 3 is recommended. Probabilities below 10^{-2} are assigned an uncertainty factor of 3. The uncertainty distribution in each case is lognormal with a median equal to P_2. Recall that P_2 is the independent warehouse damage probability, given an earthquake.

Event 3: Munitions Damaged in "L" Warehouses

If munition damage results from building collapse, the uncertainty in Event 3 is negligible because the analysts are very confident (i.e., essentially certain) that munition damage occurs. If the warehouse remains intact, the uncertainty in Event 3 is dominated by the uncertainty in P_p - the conditional probability that a fallen container is punctured. From Table 5-17 the uncertainty distribution is lognormal with an uncertainty factor of 5 and a median equal to the point estimate for P_p.

Event 4: Ignition at "M" Warehouses

The ignition probability is a function of P_{osp} and P_{EL}, that is, the probability that offsite power is available following the quake, and that an electrical fault occurs. The uncertainty in these probabilities was quantified using the methodology reported in the Zion PRA. Moreover, the data used to quantify the uncertainty in P_{osp} also comes from the Zion study.

The major uncertainty in P_{EL} is due to the application of a generic Modified Mercalli fragility model to the warehouses. Depending upon the actual, as-built design features, the median failure threshold can vary by a factor of 2 about the nominal value. Thus, an uncertainty factor of 2 was applied to the uncertainty in the failure threshold.

Event 5: Ignition at Warehouse with Damaged Munitions

All parameters and distributions required to quantify the uncertainty in Event 5 are presented in the Event 4 analysis.

5.5.2.5. Handling Accident Sequence Uncertainties. All initiating events associated with munitions handling (i.e., drops, collisions, forklift tine punctures) were assigned an error factor of 10. The conditional probability of puncturing the munitions given any one of the initiating events is assigned an error factor of 3. The probability of causing a low-impact detonation (i.e., drop from 6 ft or lower) is assigned an error factor of 10.

5.6. REFERENCES

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6. SCENARIO LOGIC MODELS FOR HANDLING

The objectives of this section are to: (1) define those activities considered as "handling" in the analysis; (2) address the assumptions and data that have been used to evaluate the handling accident scenarios; (3) present the analytical structure of the evaluation; and (4) discuss the quantification of the accident scenarios.

Section 3 provides an overview of how munitions are handled at the site prior to the demilitarization operations. The activities associated with the handling of munitions at each disposal site are diagramed in overview form in Fig. 3-1. In brief, the Army's plan is to package the munitions in onsite transportation containers when moving them from the storage areas to the MDB. The onsite transportation container is identical to the one used in the collocation option. Spray tanks will be transported in their overpack only, which serves the same function as the onsite container for the other munitions. Handling operations include packaging and loading at the storage location and at the disposal facility unpackaging the transport containers, and transfer of the munitions to the materials handling equipment within the plant. For this study, movement by forklifts is considered to be a handling operation rather than transportation. However, onsite truck transportation is considered a transportation operation.

6.1. GENERAL HANDLING PROCEDURES AND ASSUMPTIONS

Although there may be some slight differences in the munition handling procedures at each site, for this analysis the following general assumptions were made and are intended to apply to all the sites, as appropriate:

1. Forklifts are used to move munition pallets for short distances. Electric forklifts are used inside storage igloos, warehouses, maintenance facilities, storage facilities, MHIs, or MDBs. Fossil fueled forklifts are used outside these facilities.

2. A forklift will handle one pallet or container at a time.

3. A forklift equipped with a lifting beam is used to move and carry the ton containers.

4. Ton containers will have been tested ultrasonically to determine susceptibility to leak development in the plug and valve area during transportation. The ton containers indicating potential leak development will have both their valves and plugs replaced with plugs. The handling activities associated with these operations are considered "preparatory" procedures and are not part of this risk analysis. Further, it is assumed that the ton containers will not leak thereafter and this analysis does not address handling of leaking ton containers.

5. Mines will be transported with their fuzes still in the drums.

6. The spray tanks and Weteye bombs will not be removed from their overpack and will not be placed in onsite transportation containers. These items are handled with forklifts with tines.

7. Munitions will be placed in an onsite transportation container positioned just outside the storage facility (igloo apron, warehouse, or storage yard's entrance) using forklifts.

8. The onsite container has a thickness equivalent to 0.375-in. steel and is designed to provide the munitions with protection from impact, crush, puncture, and fire.

9. The onsite containers are not handled with forklifts with tines but with handling equipment which lifts the containers from the top, such as a forklift with lifting beams.

10. The onsite containers will be loaded onto a truck by forklift for transfer to the MHI.

11. Upon arrival at the MHI, the onsite container is unloaded from the truck using a diesel forklift which takes the container to the igloo apron. An electric forklift transfers the container to the MHI where it is stored until such time when it can be moved to the MDB for processing.

12. Spray tanks arriving at the MHI in their overpacks are unloaded from the truck using a diesel forklift with tines. An electric forklift (with tines) brings them inside the MHI where they are stored like the onsite containers.

13. When the munitions are ready to be moved to the MDB, an electric forklift moves one onsite container (or one spray tank in its overpack) outside the MHI. A diesel forklift picks up the container and carries it to the MDB entrance.

14. Munitions that are found to be leaking upon arrival at the MHI will be transferred to a separate location. The logistics for leaker transfer have not been defined. Therefore, this activity has not been addressed in this risk analysis.

6.2. CHRONOLOGY OF HANDLING OPERATIONS

The handling operations were categorized primarily into two groups: (1) handling operations (HO) between the storage facilities and the MHI and (2) handling operations at the facility (HF), including movement from the MHI to the MDB entrance and then to the UPA. A third category of handling operation was also considered: Handling at the igloo prior to onsite transport to the MHI and unloading at the MHI. These operations served as the basis for the identification of relevant handling accident initiating events presented in Section 4.

The generic handling operations required for movement of these munitions are shown on Fig. 3-1. The general handling steps are as follows:

1. An electric forklift picks up a pallet of munitions inside the storage area and places it in an onsite transportation container positioned just outside the storage facility (igloo apron, warehouse, or storage yard's entrance). Two exceptions are the spray tanks and Weteye bombs which are not placed in an ONC but which are handled in their overpacks using forklifts.

2. The onsite container is loaded on a truck using handling equipment which lifts the container from the top, such as a lifting beam. Overpacks are also loaded on the truck with forklifts.

3. The truck transports the container or overpacks to the MHI.

4. Upon arrival at the MHI, the onsite container or overpacks are unloaded from the truck using a diesel forklift which takes the container to the igloo apron.

5. An electric forklift transfers the container to the MHI where it is stored until such time when it can be moved to the MDB for processing.

6. When ready for further processing, an electric forklift picks up the container inside the MHI and brings it to the MHI apron.

7. A diesel forklift picks up the container at the MHI apron and carries it to the MDB elevator where it is taken to the second level.

8. An electric forklift takes the container out of the elevator and moves it to the UPA.

Based on these handling procedures, the number of operations for each scenario is calculated.

As noted above, spray tanks and Weteye bombs are not placed inside an onsite transportation container but are handled inside their over-packs with a forklift with tines. At the storage area, an electric forklift with tines picks up these munitions in their overpack and loads them directly onto a truck awaiting immediately outside the storage area. At the MHI, the spray tanks or Weteye bombs (in their overpacks) are unloaded from the truck and stored inside the igloo in a manner similar to the onsite transportation containers. The handling steps are identical to those described for all other munitions (Fig. 3-1).

6.3. ACCIDENT SCENARIOS FOR ONSITE AND FACILITY HANDLING

According to the Master Logic Diagram (Section 4), there were three types of initiating events which could lead to agent release: munition drop, forktine puncture, and forklift collision. The list was further expanded to specific accident sequences to address conditions such as (1) where the accident occurs (i.e., storage area, MHI, etc.); (2) munition configuration (i.e., handled as pallets or singularly); and (3) the presence of any packaging (i.e., bare or in onsite transportation container). This resulted in the identification of five families of initiating events for handling, as given in Table 4-3.

Event tree logic models were developed for these five families of initiating events, as shown in Figs. 6-1 through 6-5. For each tree, the scenario begins with the disruptive occurrence at a specified location and munition configuration; the subsequent events, which affect whether or not agent is released or how much is released, were then developed.

The initiating events for the accident scenarios evaluated are largely due to operator error. Except for forklift collision accidents in which the frequency data used was derived from industry data which already incorporated human error contribution to the overall event frequency, a human reliability task analysis was performed as described below to determine the occurrence of such events as dropping of munitions, forklift tine accidents, etc. The forklift collision frequency is 4.3×10^{-6} per operation.

The event tree sequences for the onsite handling operations (HO), related to the movement of munitions to various locations, are coded differently from those at the demilitarization facility (HF). The complete list of sequences is shown in Table 6-1. For facility-related

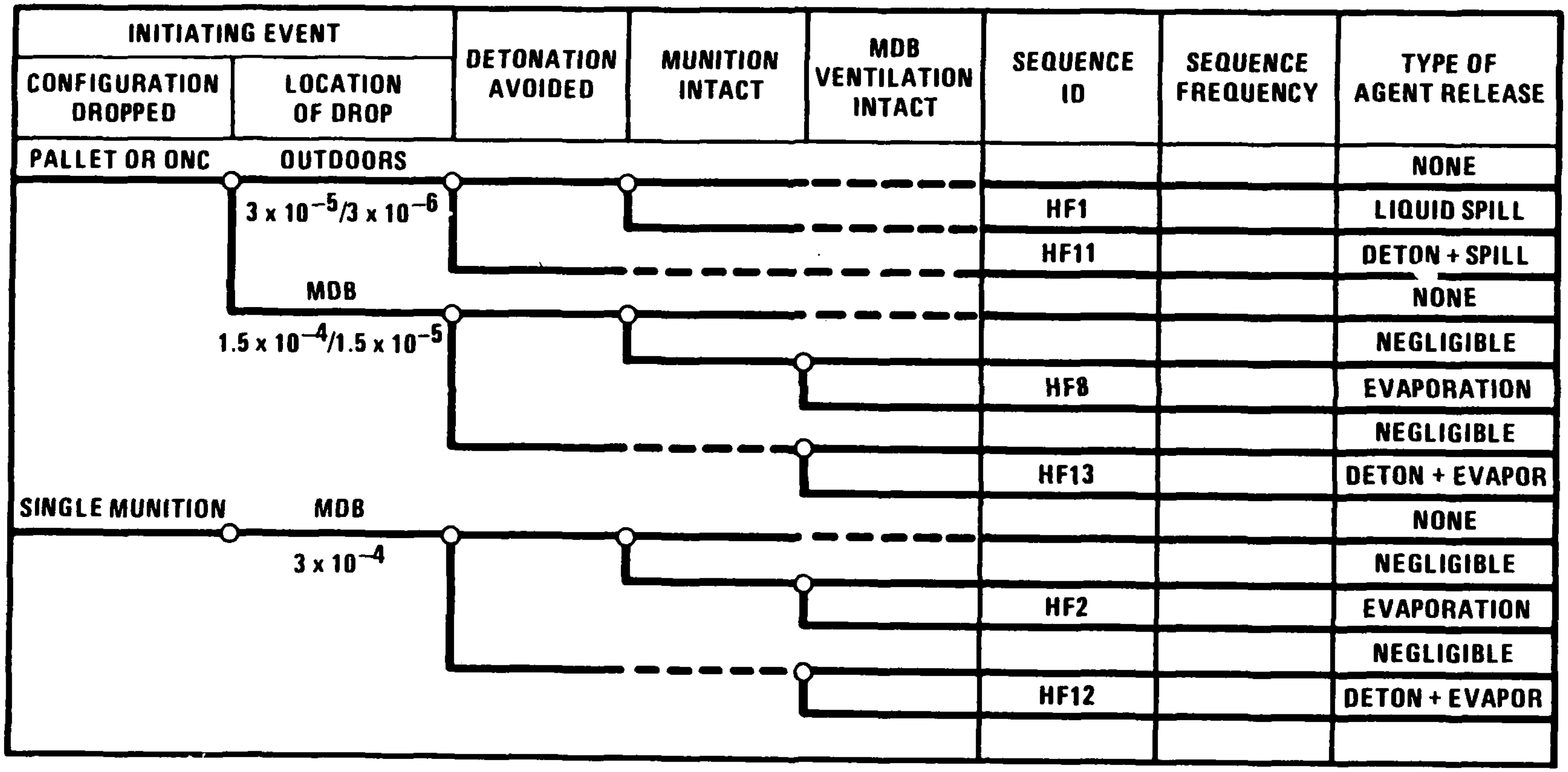

Fig. 6-1. Event tree for drop of munitions(s) during handling at facility

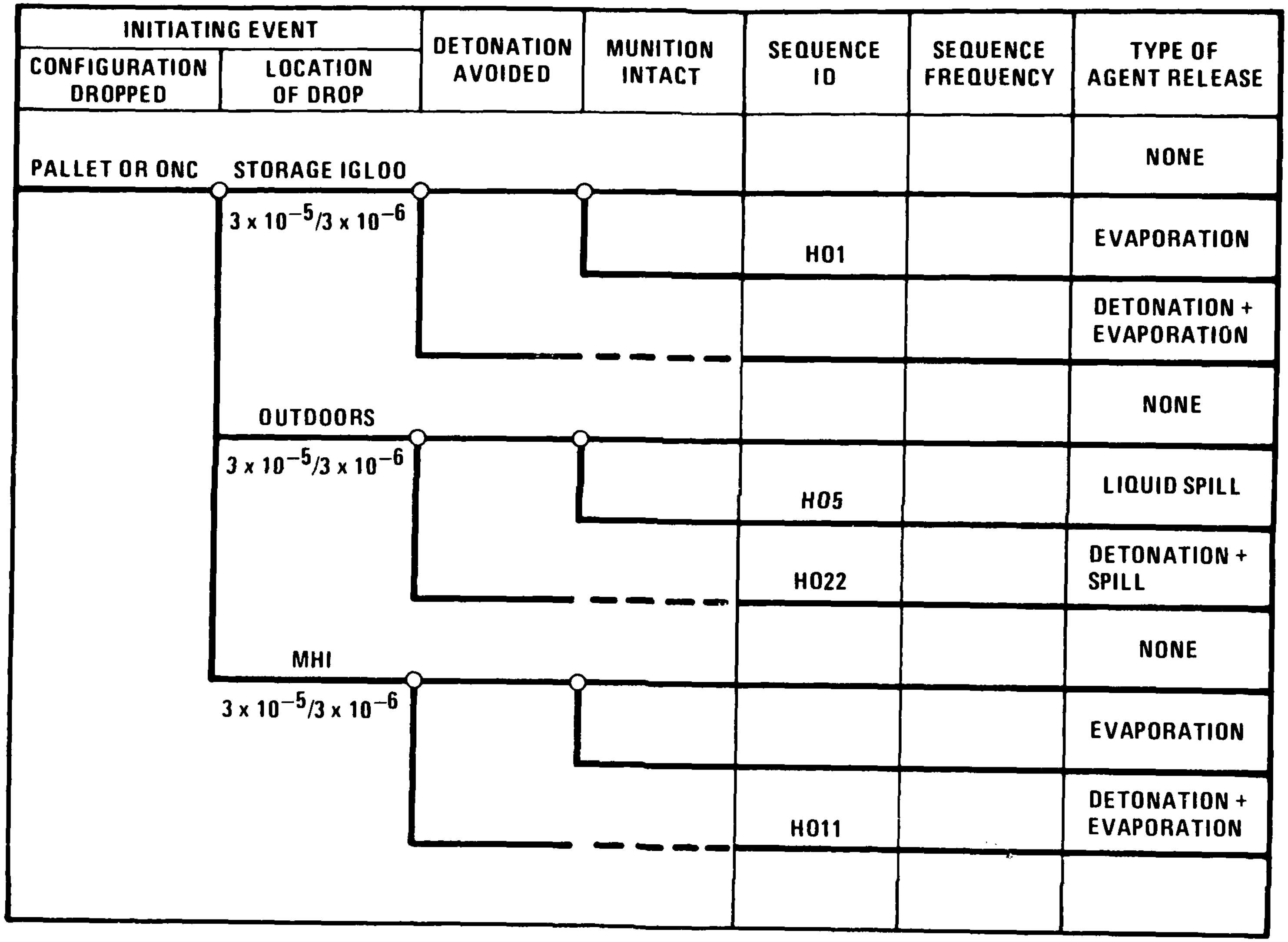

Fig. 6-2. Event tree for drop of munition(s) during handling operations other than at facility

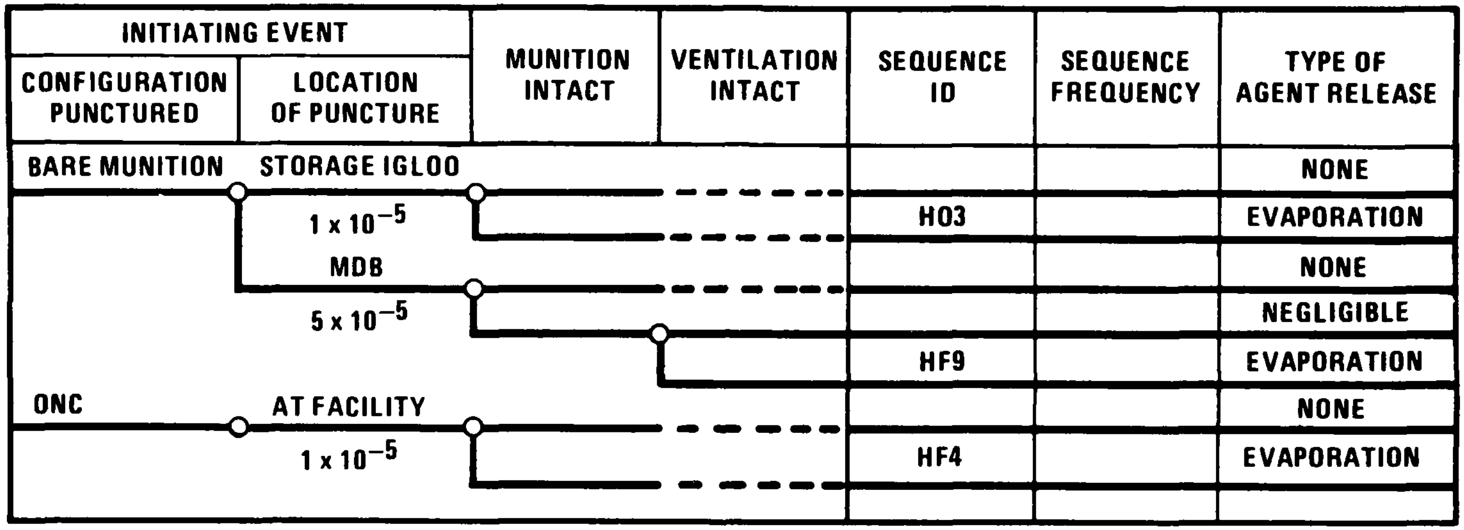

Fig. 6-3. Event tree for forklift tine punctures during handling

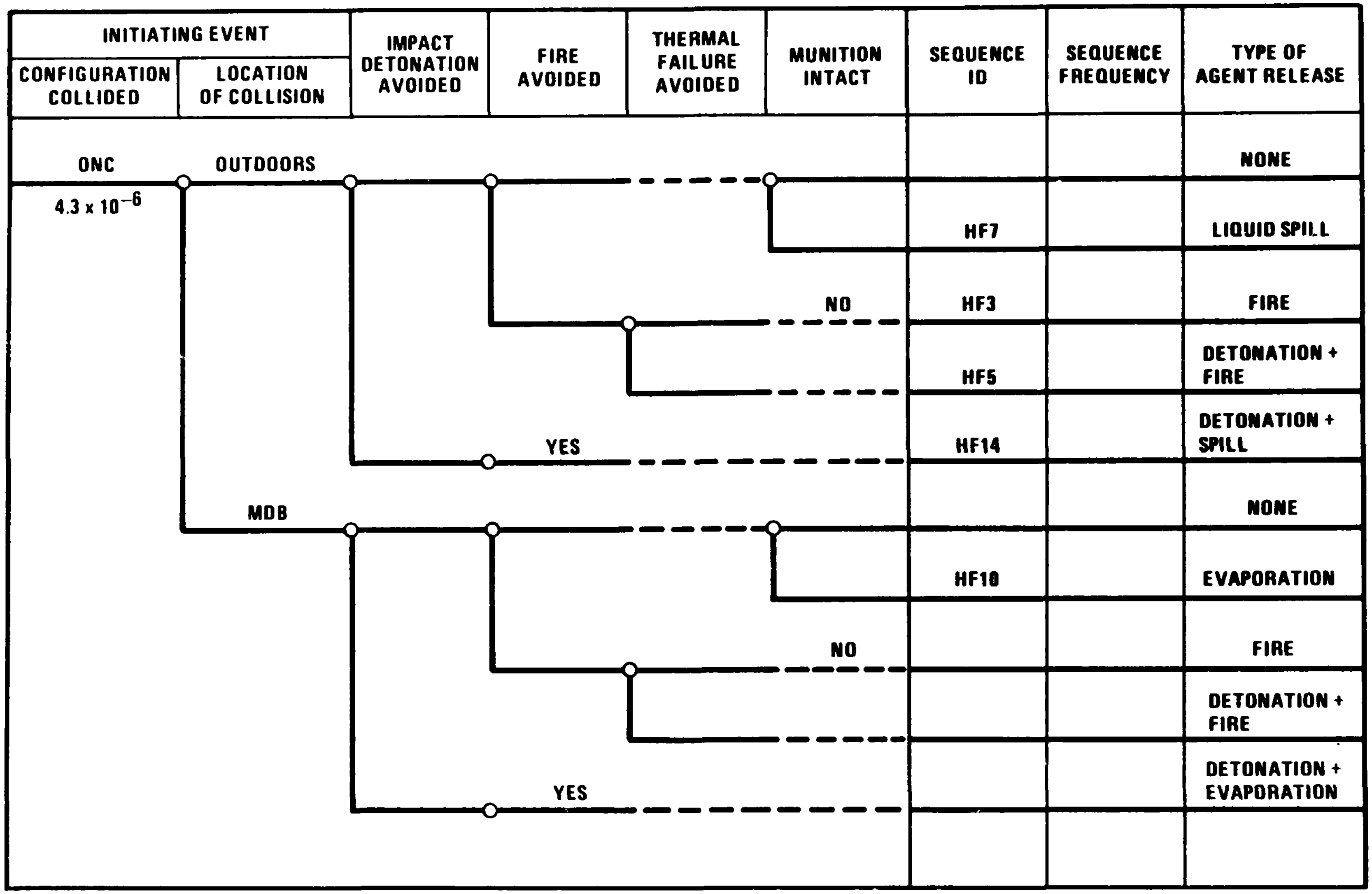

Fig. 6-4. Event tree for vehicle collisions during handling at facility

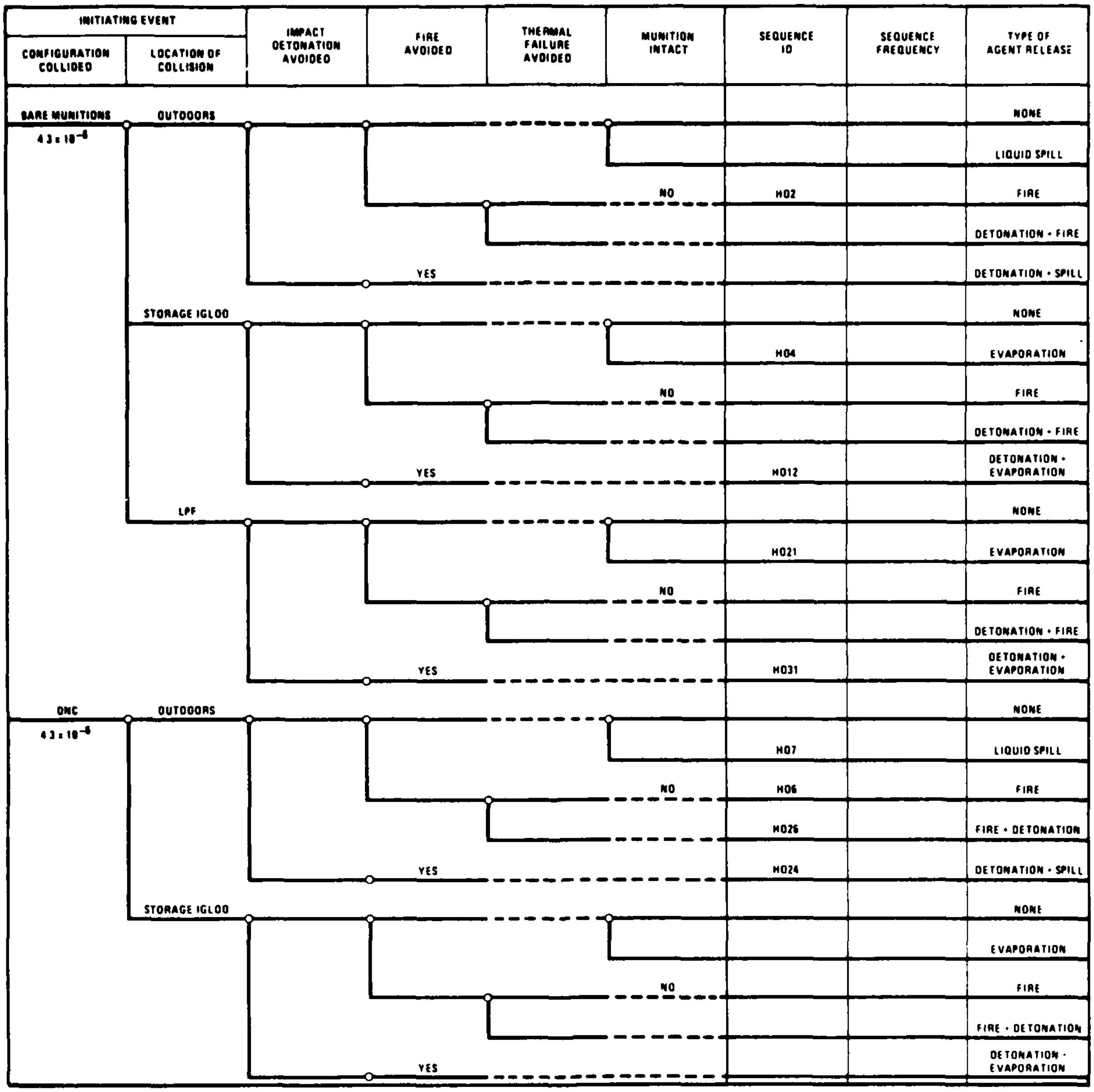

Fig. 6-5. Event tree for vehicle collisions during handling other than at facility

TABLE 6-1
LIST OF ACCIDENT SCENARIOS (HO AND HF)
ONSITE DISPOSAL OPTION

	Sequence Description	Applicable Munition Types	Munition Configuration
HO1	Drop of bare pallet or single item at storage area	All	Spray Tank (ST) in overpack
HO2	Forklift collision with short duration fire at storage area involving bare munitions	TC only	Ton container (TC) only at at APG, PBA, TEAD
HO3	Forklift tine accident involving bare munitions at storage area	All but TC	ST+overpack at storage area and MHI
HO4	Forklift collision accident without fire at storage area involving bare munitions	All	ST+overpack
HO5	Drop of onsite container	All	ST+overpack
HO6	Forklift collision with short duration fire during handling of onsite container	All	ST+overpack
HO7	Forklift collision without fire during handling of onsite container	All	ST+overpack
HO11	Drop of bare palletized munition leads to detonation	Burstered	Pallet
HO12	Forklift collision accident at storage area leads to detonation of burstered munition	Burstered	Bare
HO22	Drop of munition in onsite container leads to detonation	Burstered	ONC
HO24	Collision accident during munition handling in onsite container leads to detonation due to impact	Burstered	ONC

TABLE 6-1 (Continued)

	Sequence Description	Applicable Munition Types	Munition Configuration
HO26	Collision accident in onsite container with prolonged fire leads to thermal detonation	All	ST+overpack
HF1	Munition dropped during movement from the MHI to the MDB	All	ST+overpack
HF2	Bare single munition dropped during handling inside the MDB	All	ST without overpack
HF3	Forklift collision accident with short duration fire during handling from MHI to MDB	All	ST+overpack
HF4	Forklift tine accident during handling from MHI to MDB	ST only	ST+overpack
HF5	Forklift collision accident with prolonged fire during handling from MHI to MDB leads to detonation	All	ST+overpack
HF7	Collision accident without fire during movement from the MHI to the MDB	All	ST+overpack
HF8	Munition dropped inside the MDB (in onsite container)	All	ST+overpack
HF9	Forklift tine accident occurs inside the MDB	ST only	ST+overpack
HF10	Forklift collision accident without fire inside the MDB	All	ST+overpack
HF11	Munition pallet dropped during movement from the MHI to the MDB leads to detonation	Burstered	ONC

TABLE 6-1 (Continued)

	Sequence Description	Applicable Munition Types	Munition Configuration
HF12	Bare single munition dropped during handling inside the MDB leads to detonation	Burstered	Bare
HF13	Palletized munition in onsite container dropped during handling inside the MDB leads to detonation	Burstered	Pallet
HF14	Collision accident from MHI to MDB leads to detonation due to impact	Burstered	ONC

handling operations (HF), 13 sequences were identified and are shown in Table 6-1. The applicability of these sequences to the specific munitions stored at each site is also shown in Table 6-1.

6.3.1. Human-Reliability Analysis for Handling Operations

A human-reliability analysis (HRA) was performed in support of the handling operations analysis. This section discusses the objective of the HRA, the methodology used, the task analysis performed, the errors described, and the quantification of those errors.

6.3.1.1. Objective. The objective of the human-reliability analysis of the munitions handling operations is to identify, define, and quantify operator errors that could lead to agent release to the environment. The handling operations examined consist of all handling activities that take place before the demilitarization operations. These include all activities involving loading and unloading munitions, moving munitions with forklifts* and by hand, and packing and unpacking munition pallets. The equipment and personnel involved and the order in which the events occur are based on site visit observations, telephone conversations, and reviews of documents including "Transportation of Chemical Agents and Munitions: A Concept Plan" (Ref. 6-1) and the list of GA's handling assumptions (Ref. 6-2).

6.3.1.2. Methodology. The approach used for the human-reliability analysis is similar to the one used for plant operations (described in Plant Operations, Section 7). First, a task analysis was performed to identify those errors that could potentially impact agent release

*For this study, forklifts and other rubber-tire vehicles performing the same functions as forklifts are referred to as forklifts, and no difference in the error probabilities assigned to these various vehicles is assumed.

probabilities. Those errors were categorized according to the human operations involved; usually, no munition-specific differences were cited. Available data were used to quantify the probabilities of some of these errors, and extrapolations were made from these fixed data to quantify the remainder. Conservative error factors were selected to account for the uncertainty associated with the data, the models, the extrapolations, and site-specifics.

6.3.1.3. Task Analysis. A task analysis was performed to identify credible human errors associated with the handling operations. The sequence of handling events related to onsite disposal on which this task analysis was based is described in Sections 6.1 and 6.2. Figure 3-1 schematically represents the various handling steps. Section 9.2 contains the task-analysis table that shows precisely which human errors were identified as applicable to each operation.

All of the handling operations analyzed are performed with forklifts or by hand. Electric forklifts are used inside storage igloos, warehouses, storage facilities, MHIs and MDBs to move single munitions and pallets between the inside of the building and its apron or loading dock. Diesel forklifts are used for moving single munitions, pallets, and transportation containers between the apron or loading docks and trucks and for movement elsewhere outside. Larger forklifts, referred to as container handling equipment (for example, a "piggypacker"), are used to move transport containers. Forklift tines are used to lift pallets and spray tanks inside their overpacks. Forklift lifting beams are used to lift ton containers and transportation containers.

6.3.1.4. Human-Error Description. Four types of operator errors were identified in the task analysis: (1) puncturing a munition with a forklift tine, (2) dropping a munition or pallet from a forklift, (3) dropping a single munition while hand-carrying it, and (4) damaging a

munition or munitions in a forklift collision. These errors are described in the following paragraphs:

1. Puncturing a munition with a forklift tine might occur any time a munition or pallet is approached with a forklift tine. Puncture probability is a function of the human error that results in impact of the tine with the munition and of the vulnerability of the munition to such an impact.

2. Dropping a munition or pallet from a forklift could occur any time a forklift is carrying a load (single munitions, pallets, TCs, spray tanks, package containers, etc.). This action could be caused by operating the forklift in a way that causes the load to fall or by loading the forklift such that the load is misaligned or the weight distribution within the pallet or the package container is unbalanced. It could also result from the pallet's getting caught on and pulled off by something it has run into. Sudden acceleration or deceleration, sharp turns, high-speed operation, or operation over uneven ground could all be contributors to munition drops.

3. Dropping a munition while hand-carrying it may occur any time the munition is picked up, put down, or carried without using a forklift or other lifting device. It could be caused by the operator's falling as he carries the munition or by the munition's slipping from his grasp.

4. A forklift colliding with another vehicle or with a fixed structure is a credible human-error event, since a human is at the controls at the time of the collision. However, the data available does not distinguish between collisions caused by human error and those caused by mechanical failure. Since the two are accounted for in the collision probability estimate,

the human-error factor will not be counted again by quantifying it separately in the human-reliability analysis.

6.3.1.5. Human Error Probability Estimation. Section 9.2 discusses the human error probability estimation for the handling accidents. Most of these estimates are based on Ref. 6-3.

6.3.2. Data and Results

Tables 6-2 and 6-3 present the input data used for the accident frequency analysis. The basis for the initiating events frequencies has been discussed in the Human Reliability Analysis Section. Given the initiating event, additional events have to occur to cause an agent release to the environment. The mechanisms for release could be the breaching of munitions by puncture, impact, or detonation because of some undue force. If the accident involves a fire (e.g., collisions), thermal detonation of burstered munitions or hydraulic rupture of nonburstered munitions is possible if the fire is not suppressed. For accidents which occur in the UPA (some HF scenarios), failure of the ventilation system is critical to the amount of agent released to the environment.

Puncture Probability. The probability of puncturing a munition whether it is inside or outside a transportation container has been evaluated based on a puncture model that is a function of the probe density and length, the possible number of such probes in the area, the munition size and configuration, and drop height. Details of this model are discussed in Appendix C.

Munition Detonation. The probability of a bare munition detonating when dropped from a height of 6 ft (equivalent to a collision at 13.5 mph) is assumed to be 9.5×10^{-9}/munition. For a 4-ft drop, the corresponding probability is 3.2×10^{-10}. The probability of a munition

TABLE 6-2
INITIATING EVENTS FREQUENCIES

	INITIATING EVENT	FREQUENCY EVENTS/OP	ERROR FACTOR	REFERENCE	APPLICABLE SCENARIO
HE10	Pallet or single item dropped during handling of non-leaking munition outside the MDB (1)				HO1,HO5,HO11, HO22,HF1,HF11
HE10A	Items lifted with tines	3.0E-05	10.0		
HE10B	Items lifted with lifting beam	3.0E-06	10.0		
HE15	Pallet or container dropped during handling of non-leaking munition inside the MDB (2)				HF8,HF13
HE15A	Items lifted with tines	1.5E-04	10.0		
HE15B	Items lifted with lifting beam	1.5E-05	10.0		
HE25	Single munition dropped inside the MDB (4)	3.0E-04	10.0		HF2,HF12
HE40	Forklift tine accident involving munition handling outside the MDB (1)	1.0E-05	10.0		HO3,HF4
HE45	Forklift tine accident involving munition handling inside the MDB (2)	5.0E-05	10.0		HF9
HE55	Vehicle collision accident	4.3E-06	10.0	GA derived data, see details in Appendix F	HO2,HO4,HO6,HO7, HO12,HO24,HO26, HF3,HF5,HF7,HF10,HF14

NOTES:

(1) Handled by forklift or other handling equipment; operators wearing street clothes with mask slung

(2) Handled by forklift; operators wearing mask, gloves, and boots; excluding ton container

(4) Handled singly by hand; operators wearing mask, gloves and boots.

(6) 3.0e-5 = 3*10-5

(7) For all items lifted with tines (spray tanks in overpack and bare munitions)

(8) Items lifted by a lifting beam or by a cargo handling equipment (Ton Container, transportation con

TABLE 6-3
CONDITIONAL EVENTS PROBABILITIES

	EVENT SEQUENCE	EVENT PROBABILITY	ERROR FACTOR	REFERENCE	APPLICABLE SCENARIO
HE100	Palletized or single munition punctured given a drop outside the MDB (Drop ht = 6ft.)				H01
HE100B	Bomb	1.02E-03	3.0	See 6a calc	
HE100D	4.2-in Mortar	2.67E-04	3.0	sheets	
HE100C	105-mm Cartridge	4.73E-05	3.0	(Ref.)	
HE100K	Ton Container	3.34E-03	3.0		
HE100M	Mine (in drums)	2.00E-04	3.0		
HE100P	155-mm Projectile	0.00E+00			
HE100Q	8-in Projectile	0.00E+00			
HE100R	Rocket	7.95E-04	3.0		
HE100SW	Spray Tank (with overpack)	8.63E-03	3.0		
HE110	Container and munition punctured given a drop of the onsite container (4ft drop)				H05,H06, HF1
HE110B	Bomb	3.5E-04	3.0		
HE110D	4.2-in Mortar	3.5E-04	3.0		
HE110C	105-mm Cartridge	4.0E-05	3.0		
HE110K	Ton Container	7.2E-04	3.0		
HE110M	Mine (in drums)	4.8E-04	3.0		
HE110P	155-mm Projectile	6.0E-05	3.0		
HE110Q	8-in Projectile	6.0E-05	3.0		
HE110R	Rocket	2.7E-04	3.0		
HE140	Palletized or single munition punctured given a drop resulting from collision (Drop ht = 2ft.)				H02,H04
HE140B	Bomb	3.94E-04	3.0		
HE140D	4.2-in Mortar	1.87E-04	3.0		
HE140C	105-mm Cartridge	4.57E-06	3.0		
HE140K	Ton Container	1.68E-03	3.0		
HE140M	Mine (in drums)	1.60E-04	3.0		
HE140P	155-mm Projectile	0.00E+00			
HE140Q	8-in Projectile	0.00E+00			

TABLE 6-3 (Continued)

HE140R	Rocket	7.16E-04	3.0	
HE140SW	Spray Tank (with overpack)	6.31E-03	3.0	
HE150	Palletized munition in onsite container punctured given a drop during handling in the UPA (Drop ht = 4ft.)			H05, HF8
HE150B	Bomb	3.5E-04	3.0	
HE150D	4.2-in Mortar	3.5E-04	3.0	
HE150C	105-mm Cartridge	4.0E-05	3.0	
HE150K	Ton Container	7.2E-04	3.0	
HE150M	Mine (in drums)	4.8E-04	3.0	
HE150P	155-mm Projectile	6.0E-05	3.0	
HE150Q	8-in Projectile	6.0E-05	3.0	
HE150R	Rocket	2.7E-04	3.0	
HE160	Palletized or single munition in onsite container punctured given drop resulting from collision (Drop ht = 2ft.)			H07,HF3,HF7,HF10
HE160B	Bomb	1.0E-04	3.0	
HE160D	4.2-in Mortar	3.0E-04	3.0	
HE160C	105-mm Cartridge	0.0E+00	3.0	
HE160K	Ton Container	3.3E-04	3.0	
HE160M	Mine (in drums)	4.4E-04	3.0	
HE160P	155-mm Projectile	0.0E+00		
HE160Q	8-in Projectile	0.0E+00		
HE160R	Rocket	2.6E-04	3.0	
HE250	Single bare munition punctured given drop in UPA (Drop ht = 4ft.)			HF2
HE250B	Bomb	3.50E-04	3.0	
HE250D	4.2-in Mortar	0.00E+00		
HE250C	105-mm Cartridge	0.00E+00		
HE250K	Ton Container	2.80E-03	3.0	
HE250M	Mine (in drums)	8.82E-05	3.0	
HE250P	155-mm Projectile	0.00E+00		
HE250Q	8-in Projectile	0.00E+00		
HE250R	Rocket	5.93E-04	3.0	
HE250SO	Spray Tank (no overpack)	1.51E-02	3.0	
HE250SW	Spray Tank (with overpack)	7.87E-03	3.0	

TABLE 6-3 (Continued)

HE400	Munition punctured by forklift tines				H03,HF4, HF9
HE400B	Bomb	1.29E-02	3.0		
HE400D	4.2-in Mortar	3.68E-02	3.0		
HE400C	105-mm Cartridge	8.90E-03	3.0		
HE400K	Ton Container	N/A			
HE400M	Mine (in drums)	7.07E-02	3.0		
HE400P	155-mm Projectile	5.00E-02	3.0		
HE400Q	8-in Projectile	5.00E-02	3.0		
HE400R	Rocket	2.63E-01	3.0		
HE400S#	Spray Tank (with overpack)	1.53E-02	3.0		
HE550	Fire results from vehicle collision	7.25E-02	10.0	See App F	H02,H06, H026,HF3,HF5
HE555	Collision does not cause fire	9.27E-01	none	See App F	H04,H07, HF7
HE560	Fire contained within				H02,H06,HF3
HE560A	4 min - Burstered munitions	5.0E-01	none		
HE560B	30 min - Non burstered munitions	1.0E+00	none		
HE560C	>15 min - Onsite Container	1.0E+00	none		
HE570	Fire not contained within				H026,HF5
HE570A	4 min - Burstered munitions	5.0E-01	none		
HE570B	30 min - Non burstered munitions	0.0E+00	none		
HE570C	>15 min - Onsite Container	0.0E+00	none		
HE590	Munition in container detonates or ruptures given prolonged fire fire (>15 min for onsite container)	1.00E+00	none		H026,HF5
HE600	Munition detonates given drop (6 ft) or collision (per munition)	9.50E-09			H011
HE600D	4.2-in Mortar (48)	4.56E-07	10.0		
HE600C	105-mm Cartridge (24)	2.28E-07	10.0		
HE600M	Mine (in drums) (36)	3.42E-07	10.0		
HE600P	155-mm Projectile (8)	7.60E-08	10.0		
HE600Q	8-in Projectile (6)	5.70E-08	10.0		
HE600R	Rocket (15)	1.43E-07	10.0		

TABLE 6-3 (Continued)

HE620	Single bare munition detonates given 4 ft drop (in UPA)	3.20E-10	10.0	HF12
HE700	Munition in container detonates given drop (4 ft) or collision (per munition)	3.20E-11		H022,H024, HF11,HF13,HF14
HE700D	4.2-in Mortar (48)	1.54E-09	10.0	
HE700C	105-mm Cartridge (24)	7.68E-10	10.0	
HE700M	Mine (in drums) (36)	1.15E-09	10.0	
HE700P	155-mm Projectile (8)	2.56E-10	10.0	
HE700Q	8-in Projectile (6)	1.92E-10	10.0	
HE700R	Rocket (15)	4.80E-10	10.0	
HE800	MDB Ventilation System Failure	1.00E-09	10.0	HF2,HF8,HF9,HF10

inside a transportation container detonating when dropped is judged to be lower. Here credit is taken for the cushioning effect provided by the dunnage and packaging material inside the container. It is assumed that this will essentially reduce the impact velocity experienced by the munition itself by 30%, thus reducing the impact velocity to 9.5 mph. Using the approach outlined in Appendix C of Ref. 6-4, this results in a probability of 3.2×10^{-11}/munition for the onsite container and 3.2×10^{-12} for the offsite container.

Collision Leads to Fire. The probability value of 0.0725 was derived from Ref. 6-4, which presents data indicating that 25% of collision accidents lead to fire and 29% of collision accidents occur at 20 mph or less. This is the assumed maximum speed of the forklift during a collision.

Fire Contained. The amount of available fuel in any transportation vehicle will be limited such that it cannot sustain a prolonged fire (greater than a few minutes). For nonburstered munitions that are not in transportation containers, it takes 30 min (36 min for ton containers) of direct heating before hydraulic rupture occurs. Since the available fuel will be insufficient to support this fire duration, the probability of fire containment is 1.0. When munitions are in transportation containers, it takes at least 15 min of direct heating of an intact container to cause a thermal explosion. Again the available fuel will not be sufficient to support this fire. Hence, the probability of fire containment is also 1.0.

The results of the handling analysis are presented in Section 11 of this report. Table 6-4 summarizes the results of the frequency and uncertainty calculations for onsite and facility handling. Frequency results are median values.

TABLE 6-4
HANDLING EVENT FREQUENCIES FOR ONSITE HANDLING OPERATIONS

PAGE 1 DATE 21-Aug-87

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HOBGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.1E-08	1.3E+01	6.1E-08	1.3E+01
HODHC	1	1.6E-08	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-08	1.3E+01	1.6E-08	1.3E+01	N/A	--
HOCGC	1	2.8E-09	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-09	1.3E+01	N/A	--
HOCHC	1	2.8E-09	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-09	1.3E+01	N/A	--	N/A	--
HOKGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-08	1.3E+01	N/A	--
HOKHC	1	2.0E-08	1.3E+01	2.0E-08	1.3E+01	N/A	--	N/A	--	2.0E-08	1.3E+01	N/A	--	2.0E-08	1.3E+01	2.0E-08	1.3E+01
HOKVC	1	N/A	--	N/A	--	N/A	--	2.0E-08	1.3E+01	N/A	--	N/A	--	2.0E-08	1.3E+01	N/A	--
HOMVC	1	1.2E-08	1.3E+01	N/A	--	N/A	--	N/A	--	1.2E-08	1.3E+01	N/A	--	1.2E-08	1.3E+01	1.2E-08	1.3E+01
HOPGC	1	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	1.3E+01
HOPHC	1	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOPVC	1	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQGC	1	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HORGC	1	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	4.8E-08	1.3E+01
HORVC	1	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	N/A	--	4.8E-08	1.3E+01	4.8E-08	1.3E+01
HOSVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.2E-07	1.3E+01	5.2E-07	1.3E+01
HOKHF	2	N/A	--	5.2E-10	3.1E+01	N/A	--	N/A	--	5.2E-10	3.1E+01	N/A	--	5.2E-10	3.1E+01	N/A	--
HOBGC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-07	1.3E+01	1.3E-07	1.3E+01
HODHC	3	3.7E-07	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.7E-07	1.3E+01	3.7E-07	1.3E+01	N/A	--
HOCGC	3	8.9E-08	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.9E-08	1.3E+01	N/A	--
HOCHC	3	8.9E-08	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	8.9E-08	1.3E+01	N/A	--	N/A	--
HOMVC	3	7.1E-07	1.3E+01	N/A	--	N/A	--	N/A	--	7.1E-07	1.3E+01	N/A	--	7.1E-07	1.3E+01	7.1E-07	1.3E+01
HOPGC	3	5.0E-08	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	5.0E-08	1.3E+01
HOPHC	3	5.0E-08	1.3E+01	N/A	--	5.0E-08	1.3E+01	N/A	--	N/A	--	5.0E-08	1.3E+01	5.0E-08	1.3E+01	N/A	--
HOPVC	3	5.0E-08	1.3E+01	N/A	--	5.0E-08	1.3E+01	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	5.0E-08	1.3E+01
HOQGC	3	5.0E-08	1.3E+01	N/A	--	5.0E-09	1.3E+01	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	5.0E-06	1.3E+01
HOQVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	5.0E-08	1.3E+01
HORGC	3	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	2.6E-06	1.3E+01
HORVC	3	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	N/A	--	2.6E-06	1.3E+01	2.6E-06	1.3E+01

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HOSVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.6E-07	1.3E+01	4.6E-07	1.3E+01
HOBGC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.7E-09	1.3E+01	1.7E-09	1.3E+01
HODHC	4	8.0E-10	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-10	1.3E+01	8.0E-10	1.3E+01	N/A	--
HOCGC	4	2.0E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-11	1.3E+01	N/A	--
HOCHC	4	2.0E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-11	1.3E+01	N/A	--	N/A	--
HOKGC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.7E-09	1.3E+01	N/A	--
HOKHC	4	7.2E-09	1.3E+01	6.7E-09	1.3E+01	N/A	--	N/A	--	6.7E-09	1.3E+01	N/A	--	6.7E-09	1.3E+01	7.2E-09	1.3E+01
HOKVC	4	N/A	--	N/A	--	N/A	--	7.2E-09	1.3E+01	N/A	--	N/A	--	6.7E-09	1.3E+01	N/A	--
HOMVC	4	6.9E-10	1.3E+01	N/A	--	N/A	--	N/A	--	6.9E-10	1.3E+01	N/A	--	6.9E-10	1.3E+01	6.9E-10	1.3E+01
HOPGC	4	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOPHC	4	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOPVC	4	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQGC	4	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HORGC	4	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	3.1E-09	1.3E+01
HORVC	4	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	N/A	--	3.1E-09	1.3E+01	3.1E-09	1.3E+01
HOSVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-08	1.3E+01	2.7E-08	1.3E+01
HOBGS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	1.3E+01	6.3E-09	1.3E+01
HODHS	5	4.4E-09	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-09	1.3E+01	4.4E-09	1.3E+01	N/A	--
HOCGS	5	5.6E-10	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-10	1.3E+01	N/A	--
HOCHS	5	5.6E-10	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-10	1.3E+01	N/A	--	N/A	--
HOKGS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	N/A	--
HOKHS	5	5.0E-08	1.3E+01	5.0E-08	1.3E+01	N/A	--	N/A	--	5.0E-08	1.3E+01	N/A	--	5.0E-08	1.3E+01	5.0E-08	1.3E+01
HOKVS	5	N/A	--	N/A	--	N/A	--	5.0E-08	1.3E+01	N/A	--	N/A	--	5.0E-08	1.3E+01	N/A	--
HOMVS	5	3.4E-09	1.3E+01	N/A	--	N/A	--	N/A	--	3.4E-09	1.3E+01	N/A	--	3.4E-09	1.3E+01	3.4E-09	1.3E+01
HOPGS	5	1.1E-09	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-09	1.3E+01	1.1E-09	1.3E+01
HOPHS	5	1.1E-09	1.3E+01	N/A	--	1.1E-09	1.3E+01	N/A	--	N/A	--	1.1E-09	--	1.1E-09	1.3E+01	N/A	--
HOPVS	5	1.1E-09	1.3E+01	N/A	--	1.1E-09	1.3E+01	N/A	--	N/A	--	N/A	--	1.1E-09	1.3E+01	1.1E-09	--
HOQGS	5	1.1E-09	1.3E+01	N/A	--	1.1E-09	1.3E+01	N/A	--	N/A	--	N/A	--	1.1E-09	1.3E+01	1.1E-09	--

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TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HOQVS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-09	1.3E+01	1.1E-09	--
HORGS	5	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	1.4E-08	1.3E+01
HORVS	5	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	N/A	--	1.4E-08	1.3E+01	1.4E-08	1.3E+01
HOSVS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-06	1.3E+01	1.4E-06	1.3E+01
HOBGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.2E-11	3.1E+01	6.2E-11	3.1E+01
HODHF	6	1.9E-10	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.9E-10	3.1E+01	1.9E-10	3.1E+01	N/A	--
HOCGF	6	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--
HOCHF	6	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	N/A	--
HOKGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.1E-10	3.1E+01	N/A	--
HOKHF	6	2.1E-10	3.1E+01	2.1E-10	3.1E+01	N/A	--	N/A	--	2.1E-10	3.1E+01	N/A	--	2.1E-10	3.1E+01	2.1E-10	3.1E+01
HOKVF	6	N/A	--	N/A	--	N/A	--	2.1E-10	3.1E+01	N/A	--	N/A	--	2.1E-10	3.1E+01	N/A	--
HOMVF	6	2.7E-10	3.1E+01	N/A	--	N/A	--	N/A	--	2.7E-10	3.1E+01	N/A	--	2.7E-10	3.1E+01	2.7E-10	3.1E+01
HOPGF	6	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOPHF	6	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOPVF	6	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQGF	6	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQVF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HORGF	6	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	1.6E-10	3.1E+01
HORVF	6	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	N/A	--	1.6E-10	3.1E+01	1.6E-10	3.1E+01
HOSVF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-09	3.1E+01	3.9E-09	3.1E+01
HOBGS	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-09	1.3E+01	1.2E-09	1.3E+01
HODHS	7	3.7E-09	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.7E-09	1.3E+01	3.7E-09	1.3E+01	N/A	--
HOCGS	7	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--
HOCHS	7	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	N/A	--
HOKGS	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.1E-09	1.3E+01	N/A	--
HOKHS	7	4.1E-09	1.3E+01	4.1E-09	1.3E+01	N/A	--	N/A	--	4.1E-09	1.3E+01	N/A	--	4.1E-09	1.3E+01	4.1E-09	1.3E+01
HOKVS	7	N/A	--	N/A	--	N/A	--	4.1E-09	1.3E+01	N/A	--	N/A	--	4.1E-09	1.3E+01	N/A	--
HOMVS	7	5.4E-09	1.3E+01	N/A	--	N/A	--	N/A	--	5.4E-09	1.3E+01	N/A	--	5.4E-09	1.3E+01	5.4E-09	1.3E+01
HOFGS	7	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HOPHS	7	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOPVS	7	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQGS	7	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOQVS	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HORGS	7	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01
HORVS	7	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	N/A	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01
HOSVS	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.7E-08	1.3E+01	7.7E-08	1.3E+01
HOCHC	11	2.9E-09	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-09	2.6E+01	2.9E-09	2.6E+01	N/A	--
HOCGC	11	1.4E-09	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-09	2.6E+01	N/A	--
HOCHC	11	1.4E-09	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-09	2.6E+01	N/A	--	N/A	--
HOMVC	11	2.2E-09	2.6E+01	N/A	--	N/A	--	N/A	--	2.2E-09	2.6E+01	N/A	--	2.2E-09	2.6E+01	2.2E-09	2.6E+01
HOPGC	11	4.8E-10	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-10	2.6E+01	4.8E-10	2.6E+01
HOPHC	11	4.8E-10	2.6E+01	N/A	--	4.8E-10	2.6E+01	N/A	--	N/A	--	4.8E-10	2.6E+01	4.8E-10	2.6E+01	N/A	--
HOPVC	11	4.8E-10	2.6E+01	N/A	--	4.8E-10	2.6E+01	N/A	--	N/A	--	N/A	--	4.8E-10	2.6E+01	4.8E-10	2.6E+01
HOQGC	11	3.6E-10	2.6E+01	N/A	--	3.6E-10	2.6E+01	N/A	--	N/A	--	N/A	--	3.6E-10	2.6E+01	3.6E-10	2.6E+01
HOQVC	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.6E-10	2.6E+01	3.6E-10	2.6E+01
HORGC	11	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	9.0E-10	2.6E+01
HORVC	11	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	N/A	--	9.0E-10	2.6E+01	9.0E-10	2.6E+01
HOQHC	12	2.1E-10	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.1E-10	2.6E+01	2.1E-10	2.6E+01	N/A	--
HOCGC	12	1.0E-10	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-10	2.6E+01	N/A	--
HOCHC	12	1.0E-10	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-10	2.6E+01	N/A	--	N/A	--
HOMVC	12	1.5E-10	2.6E+01	N/A	--	N/A	--	N/A	--	1.5E-10	2.6E+01	N/A	--	1.5E-10	2.6E+01	1.5E-10	2.6E+01
HOPGC	12	3.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.4E-11	2.6E+01	3.4E-11	2.6E+01
HOPHC	12	3.4E-11	2.6E+01	N/A	--	3.4E-11	2.6E+01	N/A	--	N/A	--	3.4E-11	2.6E+01	3.4E-11	2.6E+01	N/A	--
HOPVC	12	3.4E-11	2.6E+01	N/A	--	3.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	3.4E-11	2.6E+01	3.4E-11	2.6E+01
HOQGC	12	2.6E-11	2.6E+01	N/A	--	2.6E-11	2.6E+01	N/A	--	N/A	--	N/A	--	2.6E-11	2.6E+01	2.6E-11	2.6E+01
HOQVC	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.6E-11	2.6E+01	2.6E-11	2.6E+01
HORGC	12	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	6.5E-11	2.6E+01
HORVC	12	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	6.5E-11	2.6E+01

FAGE 5 DATE 21-Aug-87

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAF FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HODHC	22	8.7E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	8.7E-11	2.6E+01	8.7E-11	2.6E+01	N/A	--
HOCGC	22	4.3E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.3E-11	2.6E+01	N/A	--
HOCHC	22	4.3E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.3E-11	2.6E+01	N/A	--	N/A	--
HOMVC	22	6.5E-11	2.6E+01	N/A	--	N/A	--	N/A	--	6.5E-11	2.6E+01	N/A	--	6.5E-11	2.6E+01	6.5E-11	2.6E+01
HOPGC	22	1.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-11	2.6E+01	1.4E-11	2.6E+01
HOPHC	22	1.4E-11	2.6E+01	N/A	--	1.4E-11	2.6E+01	N/A	--	N/A	--	1.4E-11	2.6E+01	1.4E-11	2.6E+01	N/A	--
HOPVC	22	1.4E-11	2.6E+01	N/A	--	1.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	1.4E-11	2.6E+01	1.4E-11	2.6E+01
HOQGC	22	1.1E-11	2.6E+01	N/A	--	1.1E-11	2.6E+01	N/A	--	N/A	--	N/A	--	1.1E-11	2.6E+01	1.1E-11	2.6E+01
HOQVC	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-11	2.6E+01	1.1E-11	2.6E+01
HORGC	22	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	2.7E-11	2.6E+01
HORVC	22	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	N/A	--	2.7E-11	2.6E+01	2.7E-11	2.6E+01
HODHC	24	6.2E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.2E-11	2.6E+01	6.2E-11	2.6E+01	N/A	--
HOCGC	24	3.1E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.1E-11	2.6E+01	N/A	--
HOCHC	24	3.1E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.1E-11	2.6E+01	N/A	--	N/A	--
HOMVC	24	4.6E-11	2.6E+01	N/A	--	N/A	--	N/A	--	4.6E-11	2.6E+01	N/A	--	4.6E-11	2.6E+01	4.6E-11	2.6E+01
HOPGC	24	1.0E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-11	2.6E+01	1.0E-11	2.6E+01
HOPHC	24	1.0E-11	2.6E+01	N/A	--	1.0E-11	2.6E+01	N/A	--	N/A	--	1.0E-11	2.6E+01	1.0E-11	2.6E+01	N/A	--
HOPVC	24	1.0E-11	2.6E+01	N/A	--	1.0E-11	2.6E+01	N/A	--	N/A	--	N/A	--	1.0E-11	2.6E+01	1.0E-11	2.6E+01
HOQGC	24	7.7E-12	2.6E+01	N/A	--	7.7E-12	2.6E+01	N/A	--	N/A	--	N/A	--	7.7E-12	2.6E+01	7.7E-12	2.6E+01
HOQVC	24	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.7E-12	2.6E+01	7.7E-12	2.6E+01
HORGC	24	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	1.9E-11	2.6E+01
HORVC	24	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	N/A	--	1.9E-11	2.6E+01	1.9E-11	2.6E+01
HOQGF	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HODHC	26	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOCGC	26	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--
HOCHC	26	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	N/A	--
HOPGF	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--
HOPHF	26	0.0E+00	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	0.0E+00	--
HOPVF	26	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	N/A	--

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Onsite Handling Operations (HO)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HOMVC	26	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	0.0E+00	--
HOFGC	26	0.0E+00	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HOPHC	26	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--	N/A	--
HOPVC	26	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HO3GC	26	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HCBVC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--
HORGC	26	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	0.0E+00	--
HORVC	26	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	N/A	--	0.0E+00	--	0.0E+00	--
HOSVF	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	0.0E+00	--	0.0E+00	--

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HFBGS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.2E-09	1.3E+01	4.2E-09	--
HFDHS	1	4.2E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.2E-09	1.3E+01	4.2E-09	1.3E+01	0.0E+00	--
HFCGS	1	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.8E-10	1.3E+01	0.0E+00	--
HFCHS	1	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--
HFKGS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--
HFKHS	1	8.6E-09	1.3E+01	8.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--	8.6E-09	1.3E+01	8.6E-09	1.3E+01
HFKVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--
HFMVS	1	5.8E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.8E-09	1.3E+01	0.0E+00	--	5.8E-09	1.3E+01	5.8E-09	1.3E+01
HFPGS	1	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01
HFPHS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	0.0E+00	--
HFPVS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01
HFQGS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01
HFQVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01
HFRGS	1	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01
HFRVS	1	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01
HFSVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-06	1.3E+01	1.0E-06	1.3E+01
HFBGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-16	3.1E+01	1.0E-16	3.1E+01
HFDHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--
HFKHC	2	8.4E-16	3.1E+01	8.4E-16	3.1E+01	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	8.4E-16	3.1E+01	8.4E-16	3.1E+01
HFKVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--
HFMVC	2	2.6E-17	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.6E-17	3.1E+01	0.0E+00	--	2.6E-17	3.1E+01	2.6E-17	3.1E+01
HFPGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQGS	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQVS	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRGC	2	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	1.8E-16	3.1E+01
HFRVC	2	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	1.8E-16	3.1E+01
HFSVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.5E-15	3.1E+01	4.5E-15	3.1E+01

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TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	AFG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HFBGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.1E-11	3.1E+01	3.1E-11	3.1E+01
HFDHF	3	9.4E-11	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.4E-11	3.1E+01	9.4E-11	3.1E+01	0.0E+00	--
HFCGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCHF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--
HFKHF	3	1.0E-10	3.1E+01	1.0E-10	3.1E+01	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	1.0E-10	3.1E+01	1.0E-10	3.1E+01
HFKVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--
HFMVF	3	1.4E-10	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-10	3.1E+01	0.0E+00	--	1.4E-10	3.1E+01	1.4E-10	3.1E+01
HFPGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPHF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRGF	3	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	8.1E-11	3.1E+01
HFRVF	3	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	8.1E-11	3.1E+0.
HFSVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.0E-09	3.1E+01	2.0E-09	3.1E+01
HFSVS	4	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.1E-07	1.3E+01	3.1E-07	
HFBGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFDHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKGF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKHF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKVF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFMVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HFSVF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFBGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.3E-10	1.3E+01	8.3E-10	1.3E+01
HFDHS	7	2.5E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.5E-09	1.3E+01	2.5E-09	1.3E+01	0.0E+00	--
HFCGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCHS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--
HFKHS	7	2.7E-09	1.3E+01	2.7E-09	1.3E+01	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	2.7E-09	1.3E+01	2.7E-09	1.3E+01
HFKVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--
HFMVS	7	3.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-09	1.3E+01	0.0E+00	--	3.6E-09	1.3E+01	3.6E-09	1.3E+01
HFFGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFFHS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFFVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRGS	7	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	2.2E-09	1.3E+01
HFRVS	7	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	2.2E-09	1.3E+01
HFSVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.2E-08	1.3E+01	5.2E-08	1.3E+01
HFBGC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.3E-18	3.1E+01	5.3E-18	3.1E+01
HFDHC	8	5.3E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.3E-18	3.1E+01	5.3E-18	3.1E+01	0.0E+00	--
HFCGC	8	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0E-19	3.1E+01	0.0E+00	--
HFCHC	8	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--
HFKGC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--
HFKHC	8	1.1E-17	3.1E+01	1.1E-17	3.1E+01	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	1.1E-17	3.1E+01	1.1E-17	3.1E+01
HFKVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--
HFMVC	8	7.2E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-18	3.1E+01	0.0E+00	--	7.2E-18	3.1E+01	7.2E-18	3.1E+01
HFFGC	8	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01
HFFHC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	0.0E+00	--
HFFVC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01
HFQGC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01
HFQVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01
HFRGC	8	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	4.1E-18	3.1E+01
HFRVC	8	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	4.1E-18	3.1E+01

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HFSVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-15	3.1E+01	1.2E-15	3.1E+01
HFSVC	9	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.7E-16	3.1E+01	7.7E-16	3.1E+01
HFBGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.3E-19	3.1E+01	4.3E-19	3.1E+01
HFDHC	10	1.3E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.3E-18	3.1E+01	1.3E-18	3.1E+01	0.0E+00	--
HFCGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFCHC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFKGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--
HFKHC	10	1.4E-18	3.1E+01	1.4E-18	3.1E+01	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	1.4E-18	3.1E+01	1.4E-18	3.1E+01
HFKVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--
HFMVC	10	1.9E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.9E-18	3.1E+01	0.0E+00	--	1.9E-18	3.1E+01	1.9E-18	3.1E+01
HFPGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPHC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFPVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFQVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--
HFRGC	10	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	1.1E-18	3.1E+01
HFRVC	10	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	1.1E-18	3.1E+01
HFSVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-17	3.1E+01	2.7E-17	3.1E+01
HFDHC	11	5.8E-11	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.8E-11	2.6E+01	5.8E-11	2.6E+01	0.0E+00	--
HFCGC	11	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.9E-11	2.6E+01	0.0E+00	--
HFCHC	11	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--
HFMVC	11	4.3E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.3E-11	2.6E+01	0.0E+00	--	4.3E-11	2.6E+01	4.3E-11	2.6E+01
HFPGC	11	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01
HFPHC	11	9.6E-12	2.6E+01	0.0E+00	--	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01	0.0E+00	--
HFPVC	11	9.6E-12	2.6E+01	0.0E+00	--	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01
HFQGC	11	7.2E-12	2.6E+01	0.0E+00	--	7.2E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-12	2.6E+01	7.2E-12	2.6E+01
HFQVC	11	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-12	2.6E+01	7.2E-12	2.6E+01
HFRGC	11	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	1.8E-11	2.6E+01
HFRVC	11	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	1.8E-11	2.6E+01
HFDHC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	0.0E+00	--
HFCGC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--
HFCHC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--

TABLE 6-4 (Continued)

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
HFMVC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFFGC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFFHC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	0.0E+00	--
HFFVC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFQGC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFQVC	12	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFRGC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFRVC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01
HFDHC	13	7.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-11	2.6E+01	7.2E-11	2.6E+01	0.0E+00	--
HFCGC	13	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-11	2.6E+01	0.0E+00	--
HFCHC	13	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--
HFMVC	13	5.4E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.4E-11	2.6E+01	0.0E+00	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
HFFGC	13	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01
HFFHC	13	1.2E-11	2.6E+01	0.0E+00	--	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01	0.0E+00	--
HFFVC	13	1.2E-11	2.6E+01	0.0E+00	--	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01
HFQGC	13	9.0E-12	2.6E+01	0.0E+00	--	9.0E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-12	2.6E+01	9.0E-12	2.6E+01
HFQVC	13	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-12	2.6E+01	9.0E-12	2.6E+01
HFRGC	13	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	2.2E-11	2.6E+01
HFRVC	13	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	2.2E-11	2.6E+01
HFDHC	14	1.3E-14	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.3E-14	2.6E+01	1.3E-14	2.6E+01	0.0E+00	--
HFCGC	14	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.6E-15	2.6E+01	0.0E+00	--
HFCHC	14	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--
HFMVC	14	9.9E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.9E-15	2.6E+01	0.0E+00	--	9.9E-15	2.6E+01	9.9E-15	2.6E+01
HFFGC	14	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01
HFFHC	14	2.2E-15	2.6E+01	0.0E+00	--	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01	0.0E+00	--
HFFVC	14	2.2E-15	2.6E+01	0.0E+00	--	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01
HFQGC	14	1.7E-15	2.6E+01	0.0E+00	--	1.7E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.7E-15	2.6E+01	1.7E-15	2.6E+01
HFQVC	14	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.7E-15	2.6E+01	1.7E-15	2.6E+01
HFRGC	14	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	4.1E-15	2.6E+01
HFRVC	14	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	4.1E-15	2.6E+01

6.4. UNCERTAINTY ANALYSIS

The values shown in the range factor column represent the ratios of the 95th percentile values to the median values. The range factors vary from 13 to 31. The accident sequence frequencies with the largest uncertainty involve: (1) forklift collision accidents with fire (H06, HF3) and (2) munition drop accidents inside the MDB. For the latter, the additional failure of the ventilation system for an agent-release to the atmosphere to occur is a contributor to the overall uncertainty in the results.

The assignment of error factors to the accident frequency or event probability data was based entirely on engineering judgment. For the handling accidents, the initiating event itself (drop, collision, forklift time puncture) is assigned an error factor of 10. The puncture probability given a drop or collision is assigned an error factor of 3. An error factor of 10 is assigned to the following events: (1) probability of fire given a collision; (2) ventilation system failure; and (3) low-impact detonation of burstered munitions. The error factors for specific events identified in the accident analysis are shown in Tables 6-2 and 6-3.

6.5. REFERENCES

6-1. "Transportation of Chemical Agent and Munitions: A Concept Plan," Final Report, prepared for PEO-PM Cml Demil by MITRE Corp, June 30, 1987.

6-2. List of Assumptions in letter from GA to OPMCM dated April 29, 1987.

6-3. "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," NUREG/CR-1278, U.S. Nuclear Regulatory Commission, August 1983.

6-4. "Probabilities of Selected Hazards in Disposition of M55 Rockets," M55-CS-02, USATHAMA, September 22, 1985.

7. SCENARIO LOGIC MODELS FOR PLANT OPERATIONS

7.1. INTERNAL EVENTS

The discussion presented in the following paragraphs and the discussion and figures presented in Sections 7.1.1 through 7.1.4 have been taken from documentation provided by JBF Associates, Inc. with only minor editing. The material presented in Section 7.1.5 is based on material supplied by JBF Associates, Inc. but has been augmented by GA to address explosions occurring in the incineration systems.

The development of plant operations accident scenarios involved systematically evaluating each functional area of the plant to identify initiating events which, if unchecked, could lead to agent releases above the screening thresholds set by MITRE. Then, for each initiating event, possible successes and failures of the plant systems that have the potential to check the release of agent were considered. Event trees were used to identify the possible modes of accident progression.

All of the initiating events considered for the analysis of internal events are in the following categories:

1. Agent spills.
2. Detonations.
3. Fires.
4. Process upsets.

Accidents initiated by external events are discussed in Section 7.2.

Event trees show the possible modes of accident progression. The events included in the event trees are successes and failures of functions (plant systems and/or operator actions) designed to prevent agent releases. The plant systems considered include the ventilation/filtration systems, the fire suppression systems, the explosion containment system, and the process control systems.

Each event tree contains a statement of the initiating event at the top, on the left-hand side. The functions that can limit agent releases are listed across the top of the event tree. The event tree branches at each function. The upward path at each branch is success (yes, the stated function worked) and the downward path is failure (no, the stated function did not work).

The order in which the functions are considered is specified by the analyst according to the order in which functions are challenged unless logical considerations of the analysis dictate otherwise. An example of a case where logical considerations dictate the listed order of a function involves the ventilation system. The ventilation system is challenged immediately whenever agent is released within the plant. However, the ventilation system is considered last on most of the event trees because (1) its function may be irrelevant (e.g., if the building integrity is lost because of a fire or explosion, agent will be released regardless of whether the ventilation system works) and (2) its failure probability is a function of other conditions that may develop (e.g., a large fire may saturate the ventilation system's filters, thus increasing the probability the ventilation system fails to prevent an agent release).

The last consideration stated above applies generally to each branch in the event tree; the failure probability of each function depends on the specific conditions implied by the path that leads to a challenge of the function. In other words, the probabilities of success and failure at each branch point in the event tree are conditioned on

the occurrence of the initiating event and the successes or failures of the preceding functions along the path that leads to the challenge of the function being considered. That is why some of the event tree functions are assigned different failure probabilities within the same tree; they are challenged on different paths of the tree.

Some scenarios were screened from the analysis based on frequency considerations. If the product of the initiating event frequency and conservative estimates of the failure probabilities of plant safety systems for a scenario is less than 10^{-10}/year, that scenario was screened from further consideration (Ref. 7-1). (The initiating event frequencies and system failure probabilities used for screening are shown on the event trees.) Other scenarios were screened based on successful operation of plant safety systems preventing significant agent releases.

Each accident scenario on each event tree is labeled with a "C" if it has been screened based on low consequence, an "F" if it has been screened based on low frequency, or a scenario identified if it is being analyzed.

A discussion of the data, and its basis, used in quantifying the fault trees and event trees is provided in Section 9.1.

7.1.1. <u>Explosive Containment Room Vestibule and Munitions Corridor</u>

The analysis reported in this section examined potential release scenarios that could occur in the Explosive Containment Room Vestibule (ECV) or Munitions Corridor. These scenarios all involve damage to one or more munitions or containers of agent with subsequent catastrophic

failure of the building structure or ventilation system. This analysis considered the following types of initiating events:

1. Simple spills of munitions that would create an evaporative source of agent greater than the screening thresholds discussed earlier.

2. Detonations of munitions that would result in a source of agent vapor greater than the screening thresholds.

3. Fires that cause rupture or damage of munitions, thereby creating a source of agent greater than the screening thresholds.

For Type 1 initiators, spills of one or two of each munition or container type were analyzed. For all munitions, it was assumed that spills of more than two at a time will not occur. It was also assumed that all processing operations will make use of two identical conveyor lines. Upsets that cause munition damage in both lines will most likely be detected immediately by some of the many sensors that monitor the system status on a continuous basis. Early detection should result in shutdown of the conveyor lines before additional munitions are damaged.

The principal mechanisms considered for munition spills in the ECV/Munitions Corridor include falls of munitions from the conveyors, resulting in puncture damage to the casings, and equipment failures (e.g., failures of conveyor stops or control system logic) that cause the munitions to fall from the conveyors.

For Type 2 initiators, detonations of one of each munition type that contains explosive components were analyzed. The principal mechanism considered for detonations in the ECV/Munitions Corridor includes falls of munitions from the conveyor with detonation on impact.

A detonation of an 8-in. projectile in the ECV will cause failure of the building and direct release of agent vapors to the environment.

Type 3 initiators were not analyzed. A fire of sufficient intensity and duration to rupture or detonate a munition or agent container is not credible for the ECV/Munitions Corridor due to the low inventory of combustibles in these areas. However, there are ignition sources in these areas (e.g., motors and cables). Therefore, scenarios involving fire subsequent to an agent spill or munition detonation were considered.

The event trees developed for initiating events in the ECV with estimated frequencies above the screening threshold are shown in Figs. 7-1 through 7-4. The ventilation system event was quantified using the fault tree presented in Fig. 7-5. Table 7-1 defines the event tree functions.

The following is a summary of the assumptions used in developing these event trees:

1. All processing operations will use two identical conveyor lines.

2. Upsets that cause munition damage in two conveyor lines at once will be detected immediately.

3. Detonations of 8-in. projectiles in the ECV will cause structural failure of the MDB, resulting in direct agent release to the environment, based on performed analysis.

4. A fire (as an initiating event) of sufficient intensity and duration to rupture or detonate a munition or agent container is not credible for the ECV/Munitions Corridor due to the low combustible inventory in these areas.

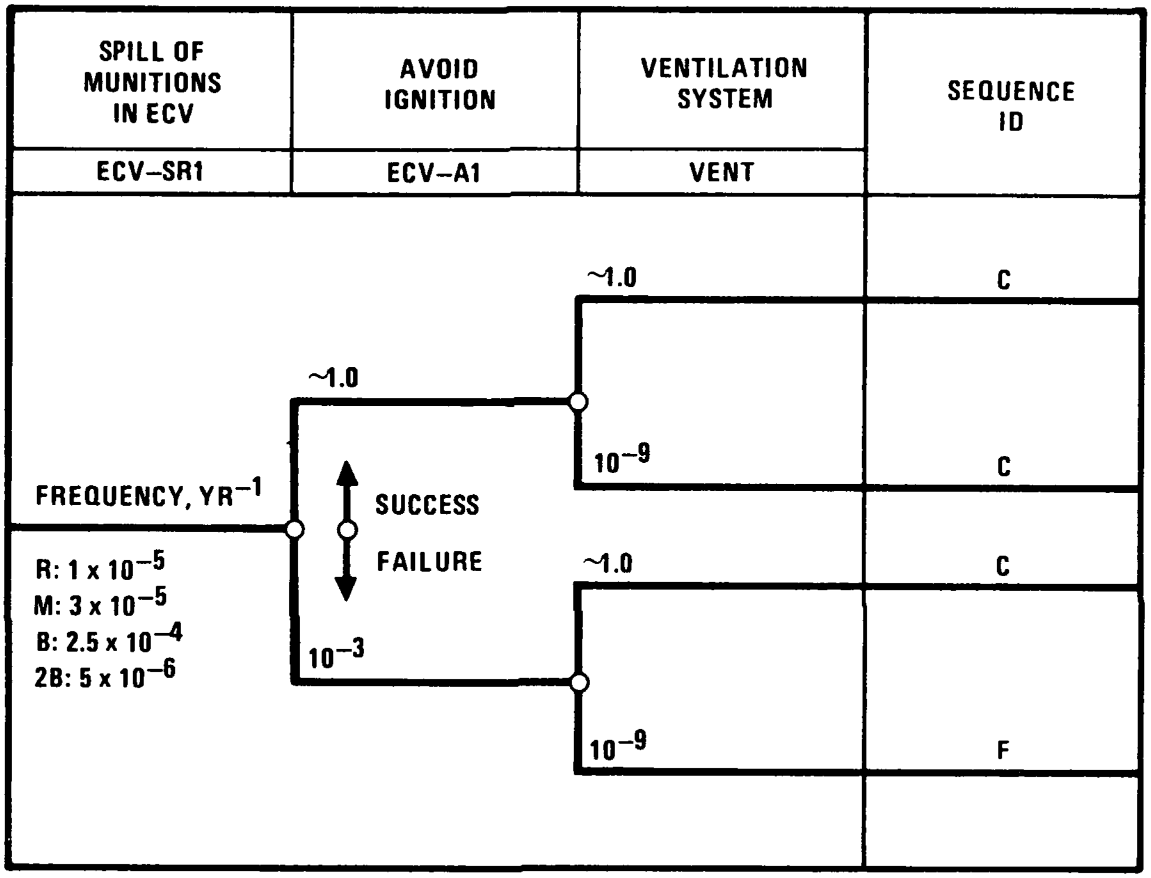

Fig. 7-1. Event tree for spill of munition(s) in the ECV

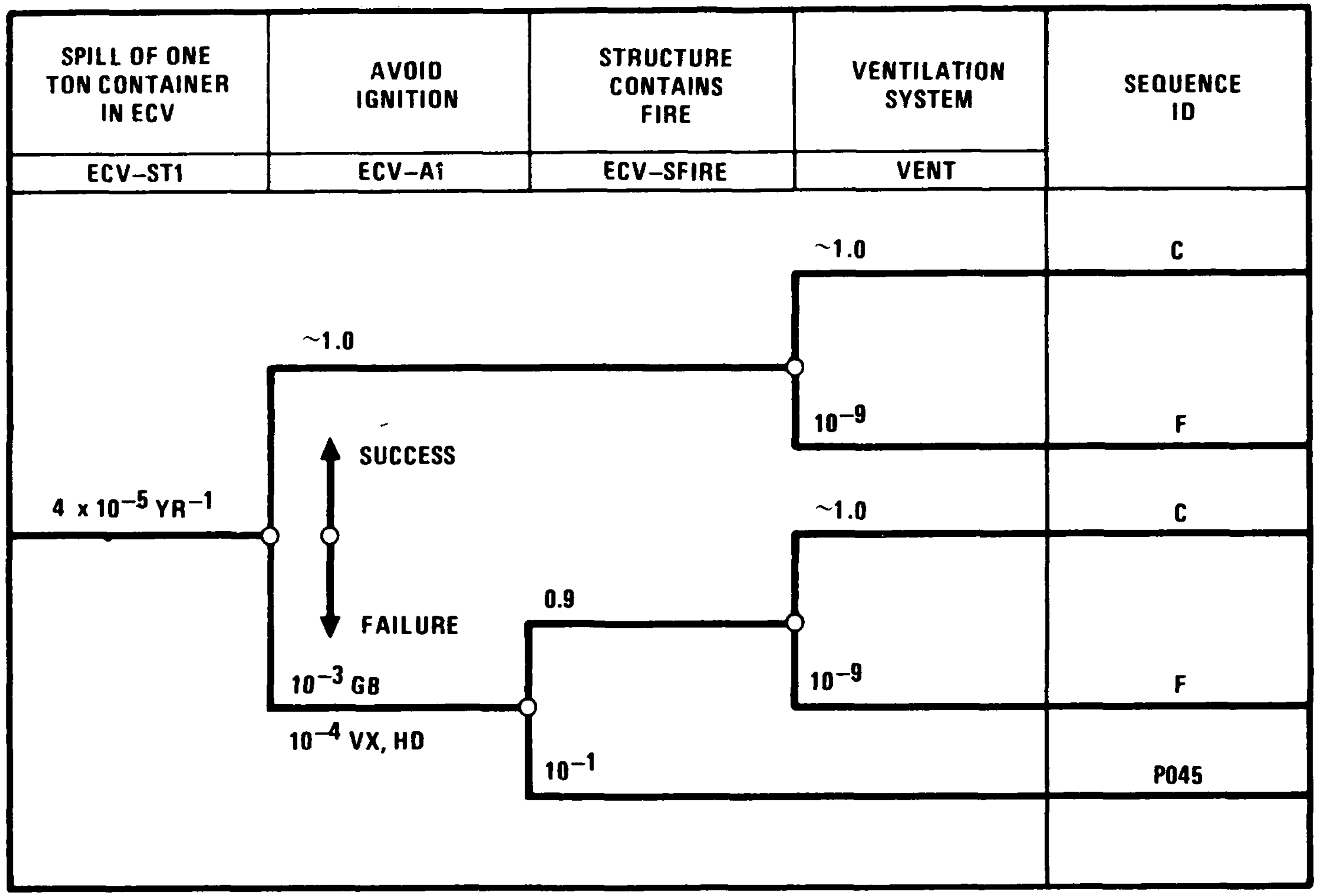

Fig. 7-2. Event tree for spill of one ton container in ECV

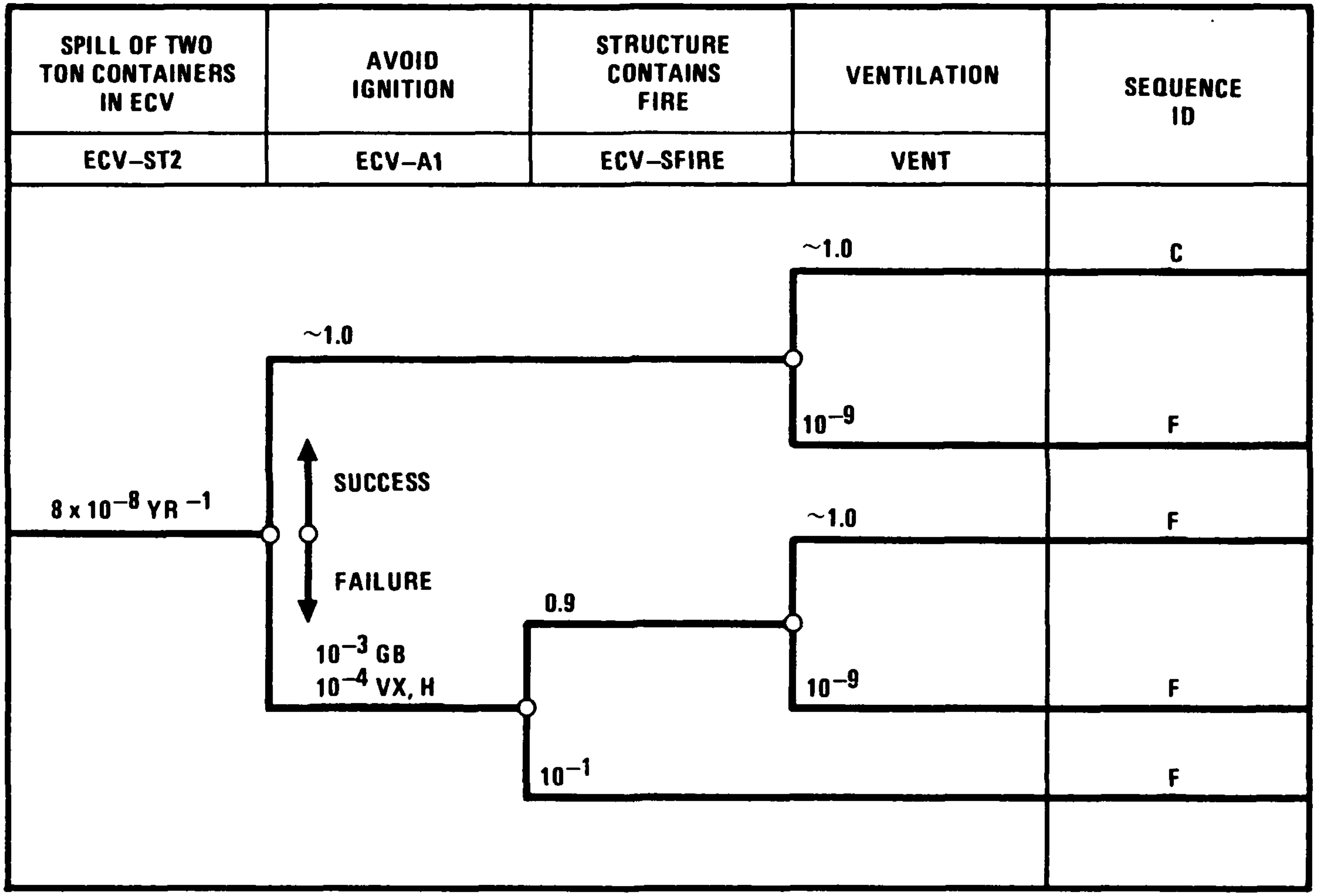

Fig. 7-3. Event tree for spill of two ton container in ECV

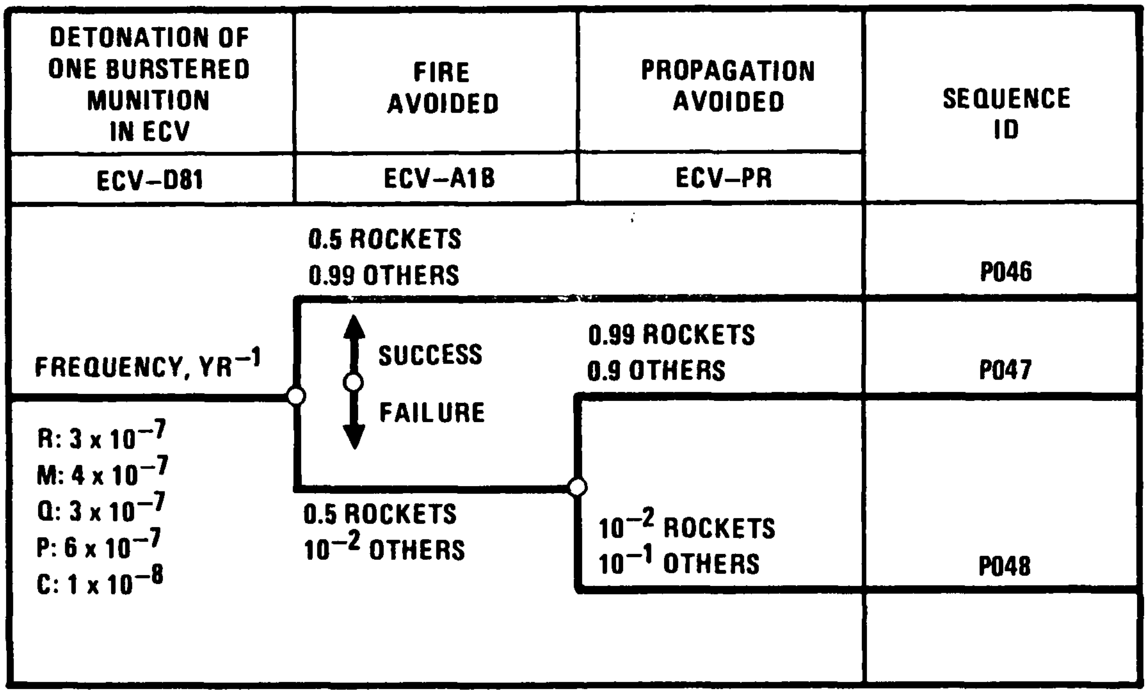

Fig. 7-4. Event tree for detonation of burstered munition in ECV

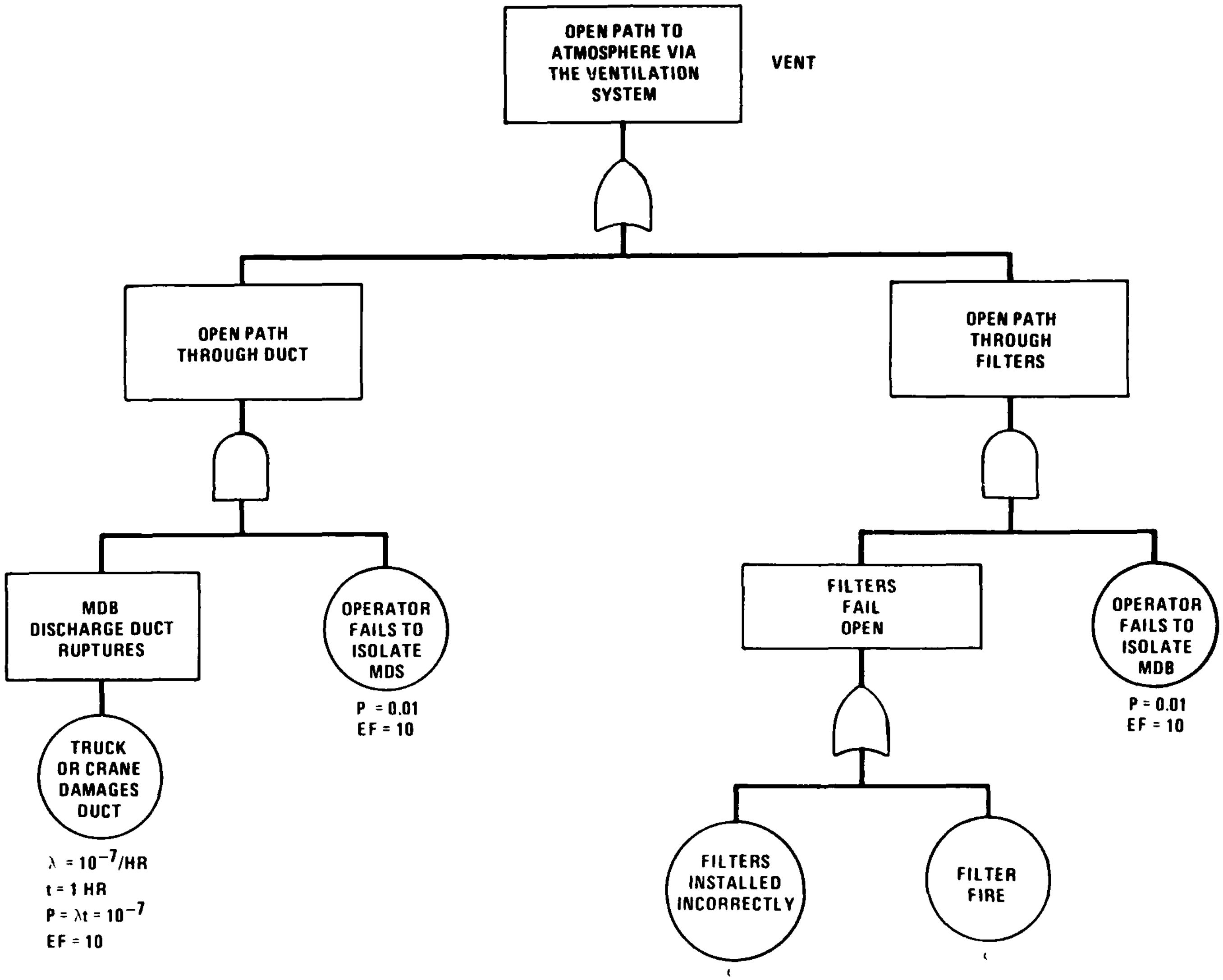

Fig. 7-5. Fault tree for agent release through the ventilation systems

TABLE 7-1
EVENTS CONSIDERED FOR THE ECV/MUNITIONS CORRIDOR

Event	Description
Spill of one rocket in ECV (ECV-SR1)	One rocket falls off the conveyor due to a process upset or improper loading and is punctured. The spill is not cleaned up in 1 h.
Spill of one mine in ECV (ECV-SM1)	One mine falls off the input conveyor due to a process upset or improper loading and is punctured. The spill is not cleaned up in 1 h.
Spill of two bombs in ECV (ECV-SB2)	One tray of bombs falls off a bypass conveyor due to improper loading or switch failures that prevent the conveyor stop from being raised until the charge can arrives. The bombs are punctured, and the spill is not cleaned up in 1 h.
Spill of one ton container in ECV (ECV-ST1)	One ton container falls off a bypass conveyor due to improper loading or switch failures that prevent the conveyor stop from being raised until the charge car arrives. The container is punctured, and the spill is not cleaned up in 1 h.
Spill of two ton containers in the ECV/COR (ECV-ST2)	One ton container on each line is damaged when a control system failure prevents the stops at the ends of the bypass conveyors from being raised when the charge car is unavailable. The containers are punctures, and the spill is not cleaned up in 1 h.
Detonation of one rocket in ECV (ECV-DR1)	A rocket falls off the input conveyor and detonates.
Detonation of one mine in ECV (ECV-DM1)	A mine falls off the input conveyor and detonates.
Detonation of one 8-in. projectile in ECV (ECV-D81)	A projectile falls off a conveyor and detonates.
Detonation of one 105-mm projectile in ECV/COR (ECV-D1051)	A projectile falls off a conveyor and detonates.

TABLE 7-1 (Continued)

Event	Description
Detonation of one 155-mm projectile in ECV/COR (ECV-D1551)	A projectile falls off a conveyor and detonates.
Avoid ignition (ECV-AI)	Failure on this event tree branch implies ignition of an agent spill. Motors and cables are potential ignition sources in the ECV.
Avoid ignition (ECV-AIB)	Failure on this event tree branch implies ignition of agent vapors and/or liquid agent spills following a munition detonation. Motors and cables are potential ignition sources in the ECV.
Ventilation system (VENT)	Failure on this event tree branch implies a release of agent through the ventilation system due to (1) duct failure or (2) filter failures. (See fault tree in Fig. 7-5.)
Propagation Avoided (ECV-PROP)	Failure on this event tree branch implies that fragments from a detonated munition hit other munitions in the ECV or the unpack area causing additional agent spillage.

5. Fires in the ECV/Munitions Corridor will not be suppressed since there are no fire suppression systems and personnel will not be sent in to fight a fire.

7.1.2. Munition Processing Systems

The analysis reported in this section examined potential failures involving all seven of the munitions processing systems. They include:

- Mine machine (MIN).
- Rocket shear machine (RSM).
- Rocket punch and drain station (RDS).
- Projectile/mortar disassembly machine (PMD).
- Burster size reduction (BSR) machine.
- Bulk drain station (BDS).
- Multipurpose demilitarization machine (MDM).

This evaluation assumed that the machines are capable of processing munitions at designed rates by completely draining agent and disassembling munitions. Also, any situation that prevents the machines from attaining those design parameters requires that the machine be shut down.

Based on these assumptions the following types of events were evaluated for each machine:

1. Simple spills of munitions that would create an evaporative source of agent greater than the screening thresholds discussed earlier.

2. Detonations of munitions that would result in a source of agent vapor greater than the screening thresholds.

3. Fires that cause rupture or damage of munitions, thereby creating a source of agent greater than the screening thresholds.

For Type 1 initiators, spills of one or more of each munition or container type were analyzed. The mechanisms considered for munition spills in the ECR or MPB include (1) random falls of munitions from the conveyors, resulting in puncture damage to the casings, (2) equipment failures (e.g., failures of conveyor stops or control system logic) that cause the munitions to fall from the conveyors, and (3) equipment failures (e.g., shearing of a partially drained rocket) that cause munitions to be processed improperly.

For Type 2 initiators, detonations of one of each munition type that contains explosive components were analyzed. The mechanisms considered for detonations in the ECR or MPB include (1) falls of munitions from the conveyor with detonation on impact and (2) process upsets or equipment failures (e.g., loss of water spray during rocket shearing) that cause munitions to be processed improperly.

It was assumed that the ECR is likely to contain a blast within its confines since it is designed and constructed to do so.

Type 3 initiators were not analyzed. A fire of sufficient intensity and duration to rupture or detonate a munition or agent container is not credible for the ECR or MPB due to the low inventory of combustibles in these areas. However, there are ignition sources in these areas (e.g., motors and cables). Therefore, scenarios involving fire subsequent to an agent spill or munition detonation were considered.

Figures 7-6 through 7-8 show the event trees for the munitions processing systems. The ventilation system event was quantified using

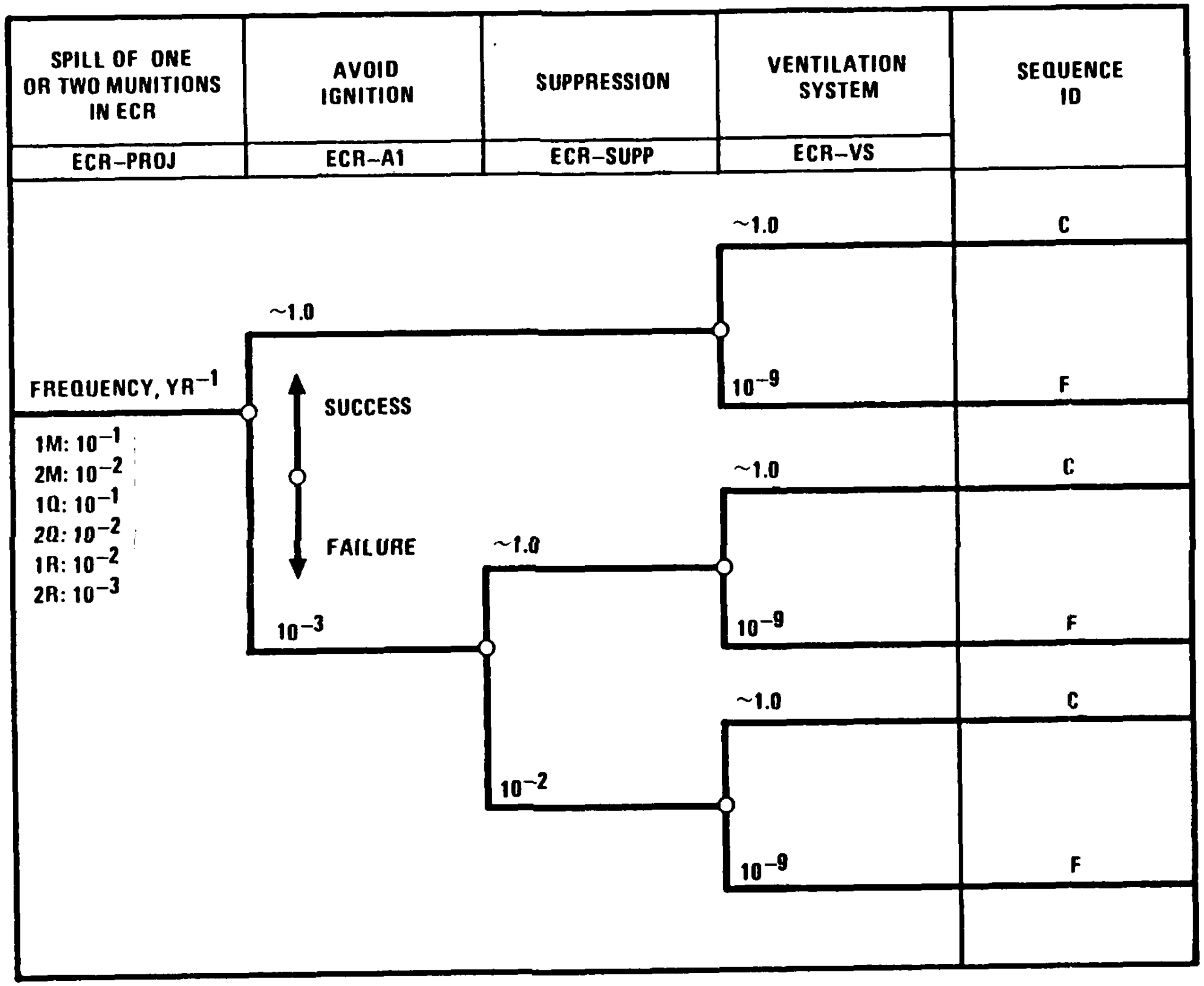

Fig. 7-6. Event tree for spill of munition(s) in the ECR

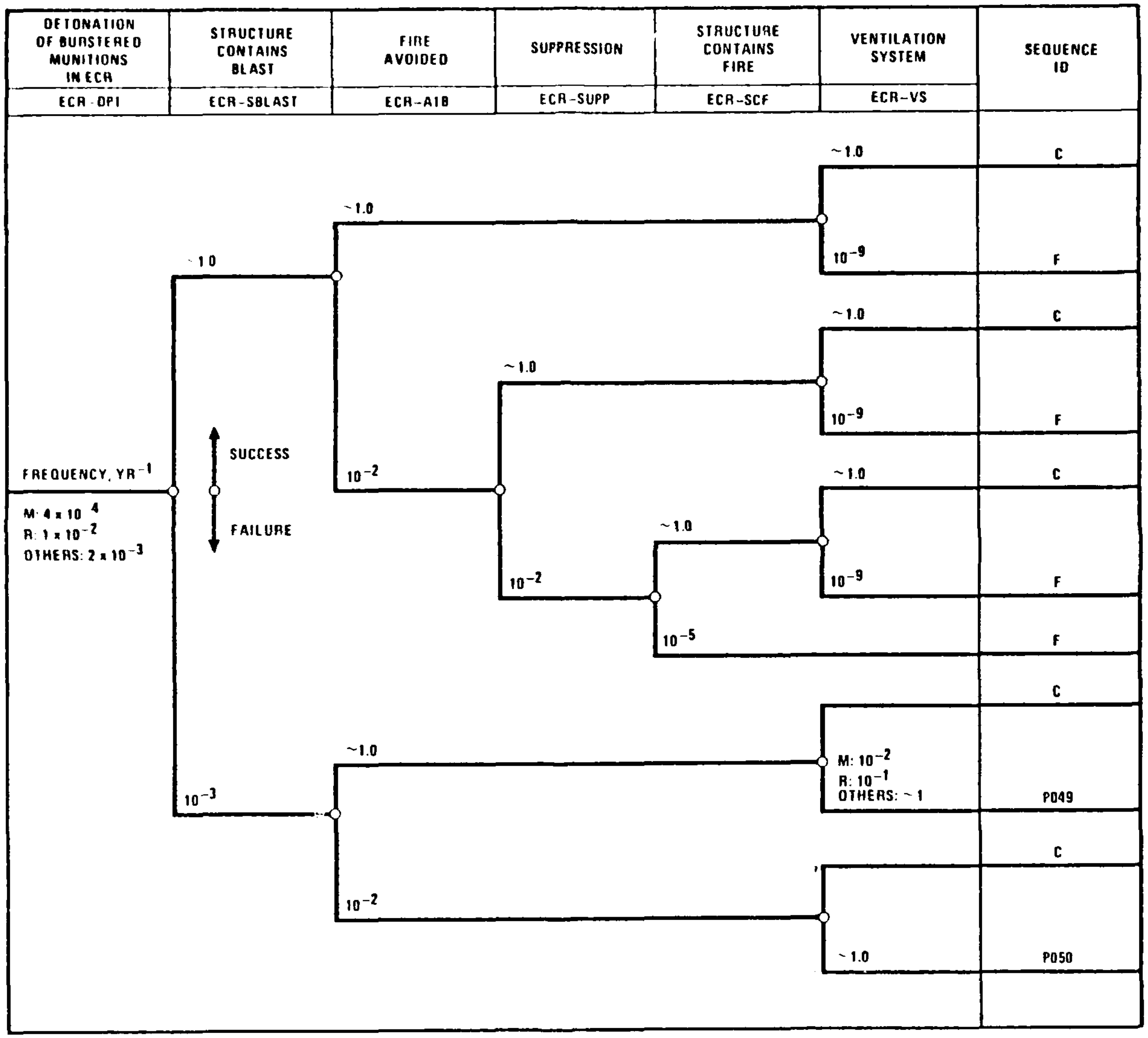

Fig. 7-7. Event tree for detonation of burstered munitions in the ECR

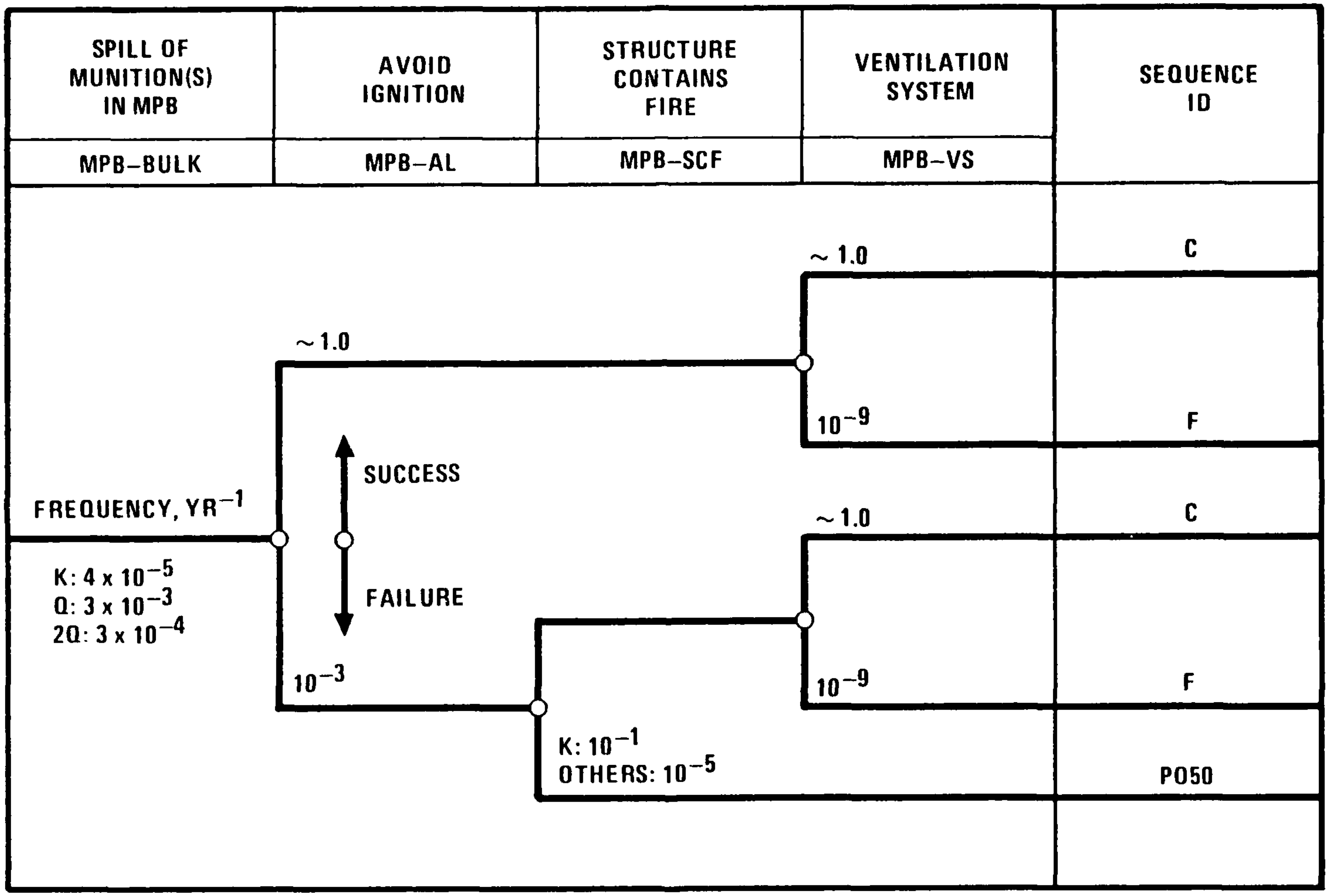

Fig. 7-8. Event tree for spill of munition in MPB

the fault tree presented in Fig. 7-5. Table 7-2 defines the event tree functions.

The following is a summary of the assumptions we made in developing these event trees:

1. All processing operations will use two identical conveyor lines.

2. Upsets that cause munition damage in two conveyor lines at once will be detected immediately.

3. Agent reservoirs within munitions are at or near atmospheric pressure.

7.1.3. Buffer Storage Area

The analysis reported in this section examined potential release scenarios that could occur in the Buffer Storage Area (BSA) on the first floor of the MDB. The BSA contains only conveyors that hold drained munitions and containers (projectiles, cartridges, bombs, and ton containers) awaiting decontamination in the Metal Parts Furnace. The only items that will contain a significant amount of residual agent after being drained are ton containers. These containers could contain 75 to 85 lb of residual agent. Therefore, the spill of one drained ton container in the BSA was analyzed. To account for the chance that an undrained munition or container could be in the BSA (due to failures in the Bulk Drain Station or the Multipurpose Demilitarization Machine), the spill of one full ton container was also analyzed. Other undrained munitions could also spill their contents in the BSA; the full ton container was selected as a representative worst-case spill for this area.

TABLE 7-2
EVENTS CONSIDERED FOR THE MUNITION PROCESSING SYSTEMS

Event	Description
Spill of mine in ECR (ECR-MIN)	Any process upset resulting in the release of the agent inventory of a mine in the ECR.
Avoid ignition (ECR-AI)	Failure on this event tree branch implies ignition of an agent spill. Motors and cables are potential ignition sources in the ECR.
Suppression (ECR-SUPP)	Failure on this event tree branch implies that the dampers for inlet ventilation to the ECR do not close.
Ventilation system (ECR-VS)	Failure on this event tree branch implies a release of agent through the ventilation system.
Spill of two mines in ECR (ECR-MINES)	Any process upset resulting in the release of the agent inventory of two or more mines in the ECR.
Spill of 8-in. projectile in ECR (ECR-PROJ)	Any process upset resulting in the release of the agent inventory of 8-in. projectiles in the ECR.
Spill of projectiles in ECR (ECR-PROJS)	Any process upset resulting in the release of the agent inventory of 8-in. projectile in the ECR.
Spill of rocket in ECR (ECR-ROC)	Any process upset resulting in the release of the agent inventory of a rocket in the ECR.
Spill of rockets in ECR (ECR-ROCS)	Any process upset resulting in the release of the agent inventory of two or more rockets in the ECR.
Detonation of mine(s) in ECR (ECR-DM1)	Any process upset resulting in the detonation of one or more mines in the ECR.
Structure contains blast (ECR-BLAST)	Failure on this branching operator implies that the walls, ceilings, blast dampers, or blast gates of the ECR are breached by the blast.

TABLE 7-2 (Continued)

Event	Description
Avoid ignition (ECR-AIB)	Failure on this event tree branch implies ignition of agent vapors and/or liquid agent spills following a munition detonation.
Detonation of projectile(s) in ECR (ECR-DP1)	Any process upset resulting in the detonation of one or more projectiles in the ECR.
Detonation of rocket(s) in ECR (ECR-DR1)	Any process upset resulting in the detonation of one or more rockets in the ECR.
Spill of bulk item in MPB (MPB-BULK)	Any process upset resulting in the release of the agent inventory of a bulk item in the MPB.
Avoid ignition (MPB-AI)	Failure on this event tree branch implies ignition of an agent spill. Motors and cables are potential ignition sources in the MPB.
Suppression (MPB-SUPP)	Failure on this event tree branch implies that the fire brigade does not successfully extinguish a fire in the MPB by spraying it with either decon solution or CO_2.
Ventilation system (MPB-VS)	Failure on this event tree branch implies a release of agent through the ventilation system.
Spill of bulk items in MPB (MPB-BULKS)	Any process upset resulting in the release of the agent inventory of two or more bulk items in the MPB.
Spill of 8-in. projectile in MPB (MPB-PROJ)	Any process upset resulting in the release of the agent inventory of an 8-in. projectile in the MPB.
Spill of projectiles in MPB (MPB-PROJS)	Any process upset resulting in the release of the agent inventory of two or more projectiles in the MPB.

TABLE 7-2 (Continued)

Event	Description
Avoid ignition (MPB-AIB)	Failure on this event tree branch implies ignition of agent vapors and/or liquid agent spills following a munition detonation.

Spills in the BSA can result from a ton container falling off the conveyor. For this analysis, it was assumed that the full container is punched at the Bulk Drain Station but not drained. Therefore, no puncture is required to release its contents.

Scenarios in which fires cause a release from the BSA were not analyzed since there are no combustibles in this area for sustaining a fire. However, there are ignition sources (motors and cables), so the possibility of an agent spill igniting was considered.

The event tree developed for the BSA is shown in Fig. 7-9. Descriptions of the events included in this tree are in Table 7-3. The ventilation event tree branch was quantified using the fault tree presented in Fig. 7-5.

The following is a summary of the assumptions used in developing the event tree shown in Fig. 7-9.

1. The Bulk Drain Station removes 95% of the agent in a munition or container under normal conditions.

2. All ton containers that reach the BSA have been punched at the Bulk Drain Station.

7.1.4. Toxic Cubicle

The analysis presented in this section examined potential release scenarios that could occur in the toxic cubicle (TOX). The only sources of agent in this area are the agent collection tanks and the agent collection and transfer lines. The scenarios which were analyzed involve spills of agent from these sources with subsequent failure of either the building structure or the ventilation system, resulting in a release of agent to the environment.

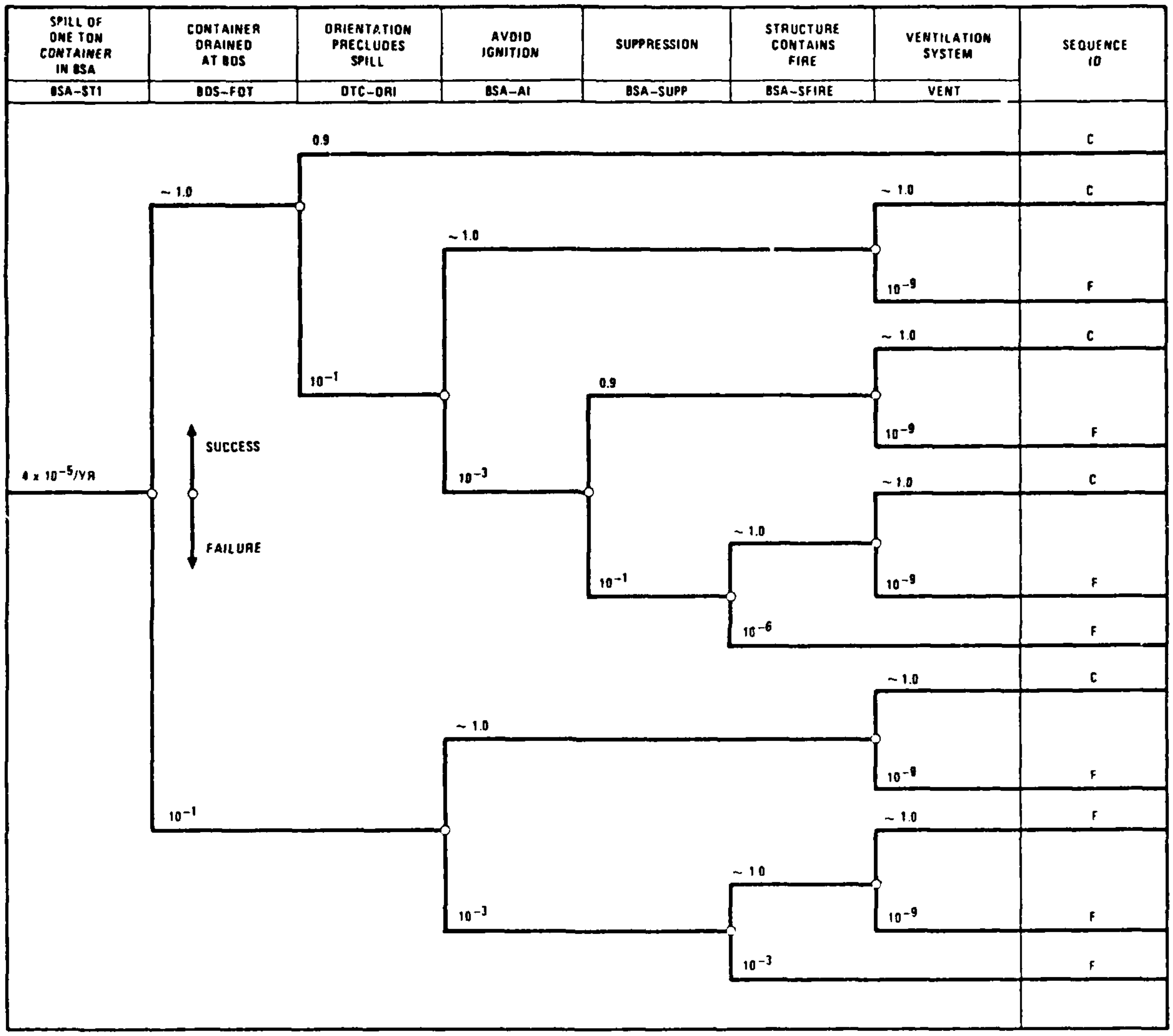

Fig. 7-9. Event tree for spill of one-ton container in the BSA

TABLE 7-3
EVENTS CONSIDERED FOR THE BSA

Spill of one ton container in BSA	A punched ton container falls off the buffer storage conveyor in the BSA.
Container drained at BDS (BDS-FDT)	Failure on this event tree branch implies that the Bulk Drain Station (BDS) did not drain a ton container before sending it on to the BSA.
Orientation precludes spill (DTC1-ORI)	Failure on this event tree branch implies that a drained ton container that is dropped lands in the proper orientation for drainage of its residual agent contents.
Avoid ignition (BSA-AI)	Failure on this event tree branch implies ignition of the agent spill. Motors and cables are potential ignition sources in the BSA.
Suppression (BSA-SUPP)	Failure on this event tree branch implies that the dampers do not successfully extinguish a fire.
Ventilation system (VENT)	Failure on this event tree branch implies a release of agent through the ventilation system due to (1) duct failure or (2) filter failures. (See fault tree shown in Fig. 7-12.)

Spills in the TOX can result from equipment ruptures (tanks, piping, or valves) or from overfilling of an agent collection tank. Rupture of a tank or of the tank outlet valves or piping would result in the spill of the entire contents of one agent collection tanks. (A 500-gal spill was assumed for this case.) On the other hand, rupture of the tank inlet valves or piping or overfilling a tank would result in a substantially smaller spill. Therefore, these two classes of spills were analyzed separately.

Scenarios in which a fire in the TOX causes a release were not analyzed since there are no combustibles in the TOX for sustaining a fire. However, there are ignition sources (motors and cables), so scenarios in which agent spills are ignited were analyzed.

The accident event trees developed for the TOX are shown in Figs. 7-10 and 7-11. Table 7-4 provides descriptions of the events used to construct these event trees, and Fig. 7-12 shows the fault tree which was constructed to quantify the fire suppression event. The ventilation system event was quantified using the fault tree presented in Fig. 7-5.

7.1.5. Incinerator Systems

7.1.5.1. Furnace Explosions. Four furnaces are used in the MDB:

1. The Liquid Incinerator (LIC).
2. The Metal Parts Furnace (MPF).
3. The Deactivation Furnace System (DFS).
4. The Dunnage Incinerator (DUN).

Analyses of explosions resulting from operating these furnaces focused upon two generic explosion scenarios:

1. Furnace explosions - in which the combustible material is initially confined to the furnace interior.

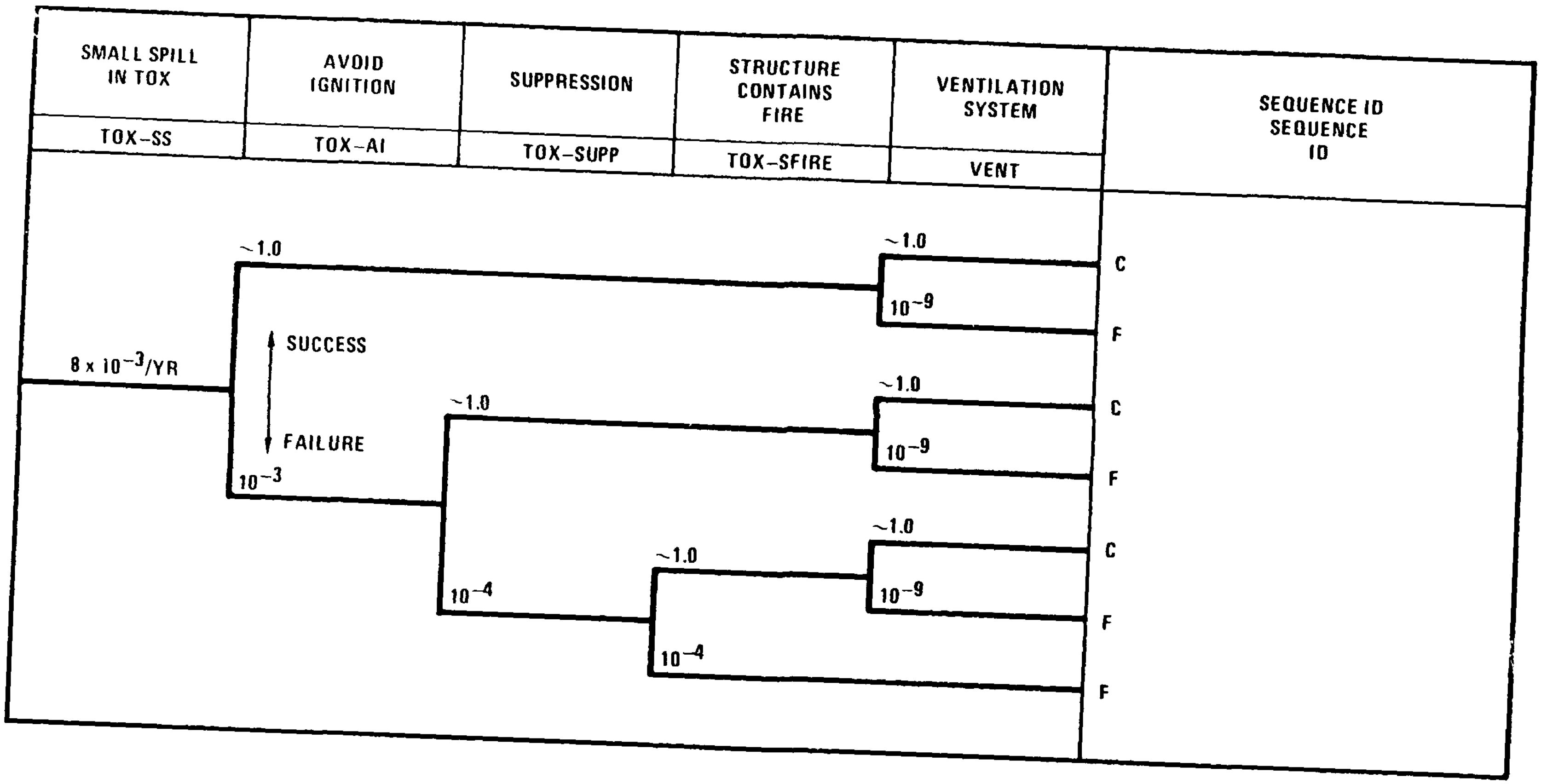

Fig. 7-10. Event tree for a small spill in the TOX

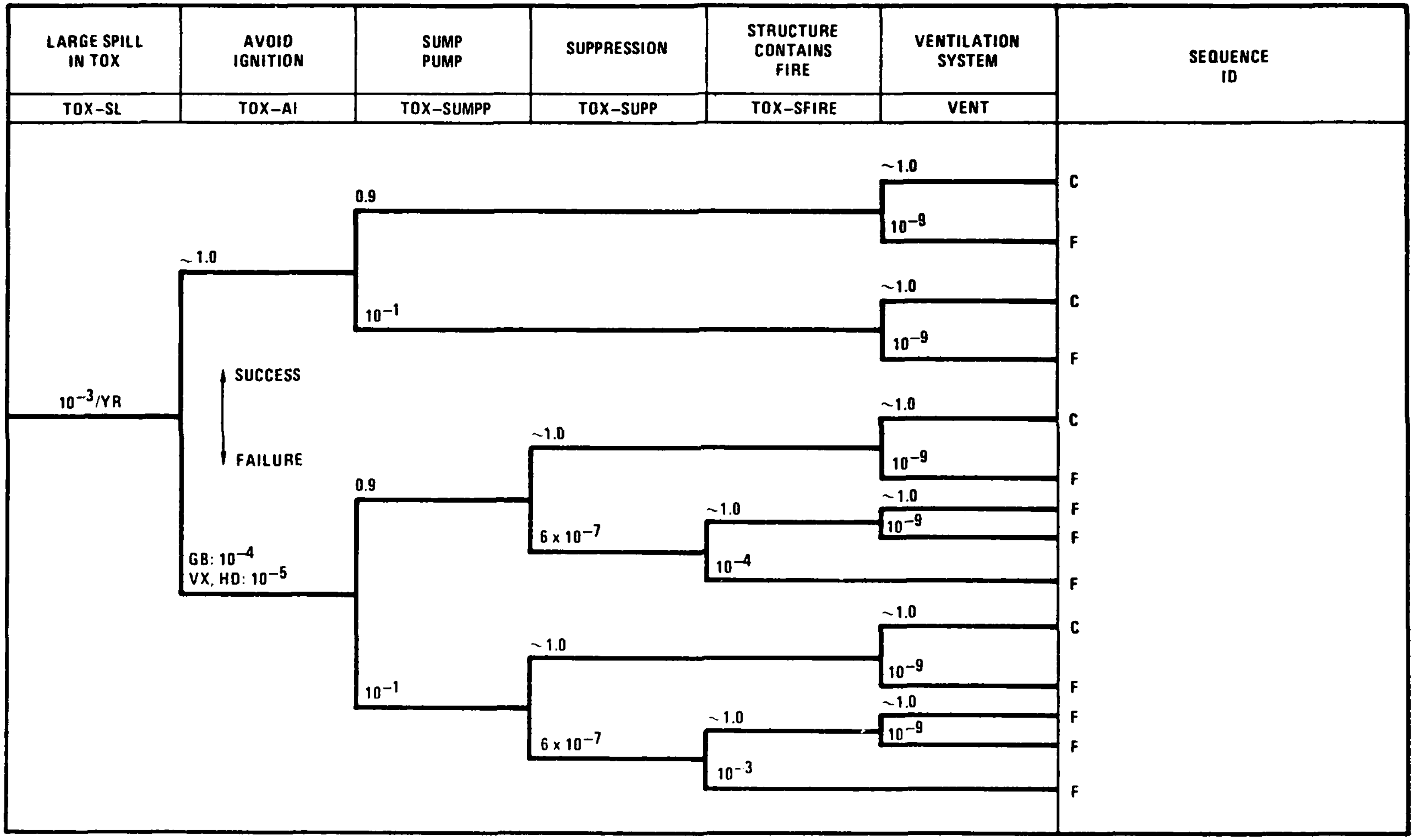

Fig. 7-11. Event tree for a large spill in the TOX

TABLE 7-4
EVENTS CONSIDERED FOR THE TOX

Event	Description
Large spill in TOX (TOX-SL)	The contents of one agent collection tank (500 gal) are spilled onto the floor of the TOX due to rupture of the tank itself or rupture of outlet valves or piping. The frequency is dominated by pipe failure with a rate of 10^{-3}/yr.
Small spill in TOX (TOX-SS)	An amount of agent less than the volume of one agent collection tank is spilled onto the floor of the TOX (typically less than 50 gal) due to tank overfill or rupture of the tank inlet piping or valves.
Avoid ignition (TOX-AI)	Failure on this event tree branch implies ignition of the agent spill. Motors and cables are potential ignition sources in the TOX. This probability was subjectively estimated.
Suppression (TOX-SUPP)	Failure on this event tree branch implies that the fire suppression system does not start and that the operator fails to either (1) close the room inlet dampers or (2) turn on the dry chemical fire suppression system. (See fault tree shown in Fig. 7-12.)
Ventilation system (VENT)	Failure on this event tree branch implies a release of agent through the ventilation system due to (1) duct failure or (2) filter failures. (See fault tree shown in Fig. 7-5.)

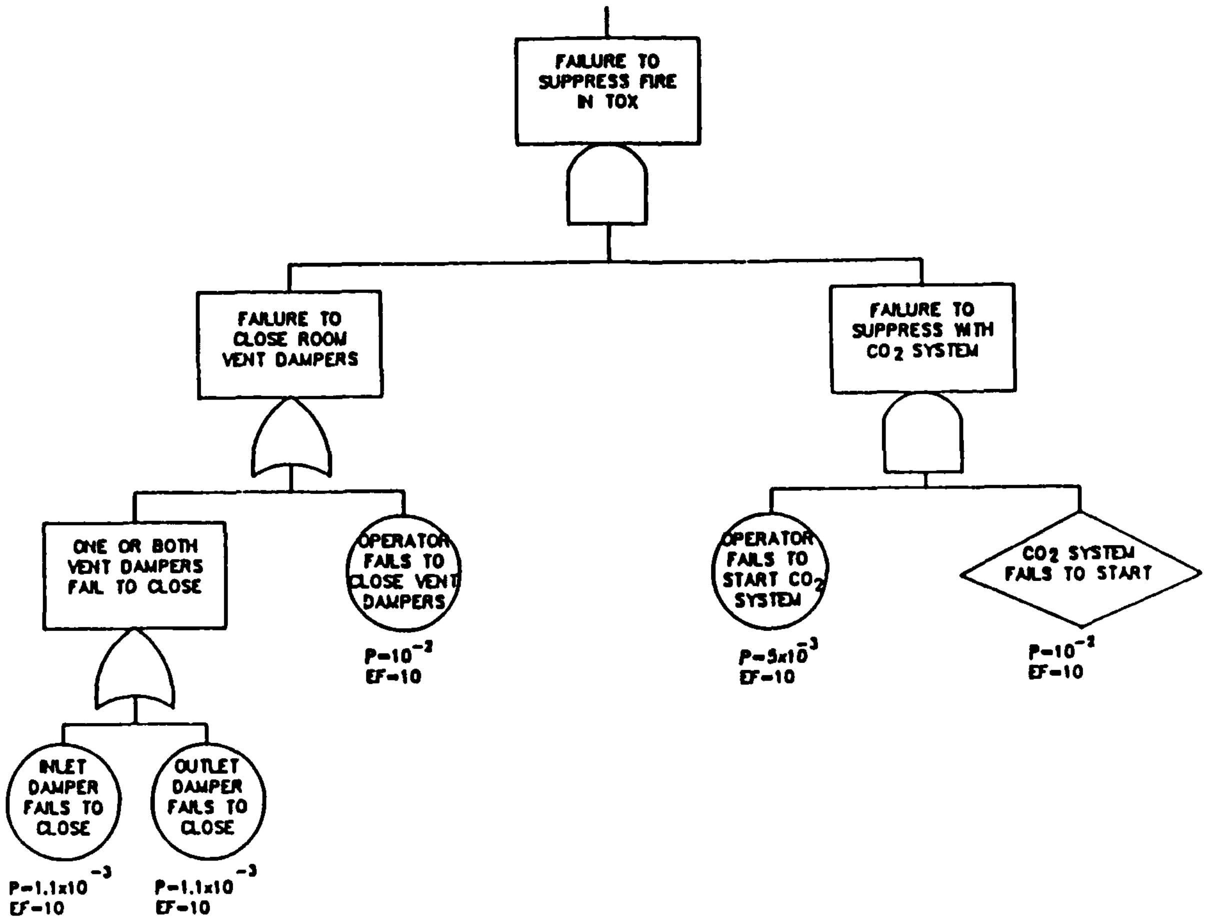

Fig. 7-12. Fault tree for failure to suppress a fire in the TOX

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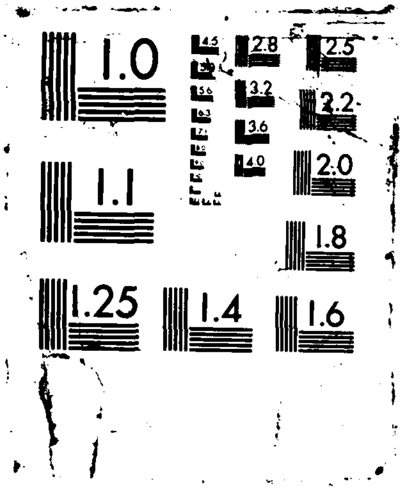
UNCLASSIFIED SAPEO-CDE-IS-87010 DAAA15-85-D-0022 F/G 15/6.3 NL


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

2. Room explosions - in which a flammable mixture forms outside of the furnace.

Room explosions do not preclude accompanying deflagration inside of the furnace.

Structural evaluations show that the LIC can contain a furnace explosion. Since there is no resultant agent release to the environment, LIC furnace explosions can be screened due to their low consequence.

A LIC room explosion can occur if, following a LIC shutdown, continued agent or fuel flow into the LIC results in a flammable mixture forming in the LIC room. However, the LIC room ventilation flow rate precludes flammable mixture formation, even if 100% agent or fuel flow continues. Because of the high ventilation system reliability, the frequency of independent failures resulting in an LIC shutdown, continued fuel or agent flow, and ventilation system failure is below the 10^{-10}/yr screening criteria.

Loss of offsite power was also investigated as an LIC room explosion initiating event, because both LIC shutdown and loss of ventilation flow occur without any electric power. Thus, at frequencies on the order of 0.1 per year, a single initiating event can cause an LIC shutdown and ventilation system failure. However, the loss of offsite power terminates agent flow since, without the pressure developed by the agent feed pump, the agent cannot physically flow through the LIC atomizer. Moreover, the valves on the LIC fuel lines are designed to fail closed upon a loss of power. These design features, in conjunction with procedures requiring that the operators close the manual fuel block valves, result in the frequency of loss of offsite power initiated explosions also being below 10^{-10}/yr.

An MPF explosion can result in an agent release to the environment if it involves an undrained or unpunched bulk item (i.e., a ton container, spray tank, or bomb). If an undrained bulk item is inadvertently fed to the MPF, the explosion involves agent deflagration. However, this type of explosion can only occur if the MPF is shut down while an undraind bulk item is being processed. Although MPF shutdowns are rather common (~7 per year), the probability of failing to drain a bulk item is so low that the frequency of an MPF explosion occurring while an undrained bulk item is being processed is below 10^{-10}/yr.

An MPF explosion will occur if an unpunched bulk item is fed to the MPF as a result of the bulk item experiencing hydraulic rupture. Hydraulic ruptures are capable of damaging the MDB and releasing virtually all of the bulk item inventory to the environment. Hydraulic ruptures have frequencies about 10^{-10}/yr.

A natural gas deflagration can also cause an MPF explosion. Since the MPF is subjected to structural failure during natural gas deflagrations, these explosions contribute to the plant risk. However, MPF room explosions are screened from the risk assessment because their frequency is below 10^{-10}/yr. This is due to the high room ventilation system reliability, a fail-safe fuel valve design, and instituted procedural requirements. Both DFS and DUN room explosions have frequencies below 10^{-10}/yr for the same reason.

Structural evaluation of DFS furnace explosions conclude that the blast is insufficient to fail the DFS room walls. Hence, any agent present when the explosion occurs will remain in the DFS room, and there will be no damage to any munitions, containers, or equipment outside of the DFS room.

The DUN furnace can contain a natural gas deflagration. Consequently, no agent release results from this scenario. However, the DUN furnace cannot survive a munition detonation. Although the probability

of inadvertently feeding a munition to the DUN is low (on the order of 10^{-7} per munition pallet or mine drum), the high munition processing rates result in DUN explosion frequencies ranging from $\sim 10^{-2}$ to $\sim 10^{-3}$ per year, depending upon the munition type. If a munition detonates in the DUN, its entire inventory is released to the environment by the detonation.

Table 7-5 describes the initiating events for LIC shutdowns. Figures 7-13 through 7-38 present the corresponding incinerator system logic models.

7.1.5.2. Dunnage Incinerator Accidents Analysis

Mines

Inadvertently feeding a mine to the Dunnage Incinerator (DUN) requires that the following three faults occur:

1. The operators mistakenly leave a mine in the dunnage box.
2. The mine counter fails.
3. The operator responsible for inspecting the dunnage box prior to charging it to the DUN fails to detect the mine.

Because of all the packing in the dunnage box, the ability of an operator to detect a mine by visual inspection is severely limited. Hence, the probability that the operator responsible for inspecting the dunnage box fails to detect the mine is essentially unity.

The mine counter has two failure modes: mechanical and human error. The dominant failure modes involves an operator failing to properly initialize the mine counter prior to unloading a drum of mines. This human error is estimated to have a 0.01 probability (Ref. 7-2).

TABLE 7-5
LIC INITIATING EVENT DESCRIPTIONS

Initiator	Description
LIC-1	These initiators are all spurious shutdown signals and process upsets which are not expected to cause agent release if no action is taken to stop the furnace operations.
	These initiators cause the loss of CA to the LIC-AB.[a]
	These initiators cause the loss of all CA to the LIC.[b]
	These initiators cause a temporary loss of fuel or CA to the LIC-AB.[c]
	These initiators cause excess feed agent to the LIC.[d]
LIC-2	These initiators cause the loss of air flow through the LIC PAS.
LIC-3	These initiators cause the loss of natural gas to all furnaces.
LIC-4	These initiators cause the loss of fuel to the lIC-AB.

[a]This initiator was previously designated LIC-5.

[b]This initiator was previously designated LIC-6.

[c]This initiator was previously designated LIC-7.

[d]This initiator was previously designated LIC-8.

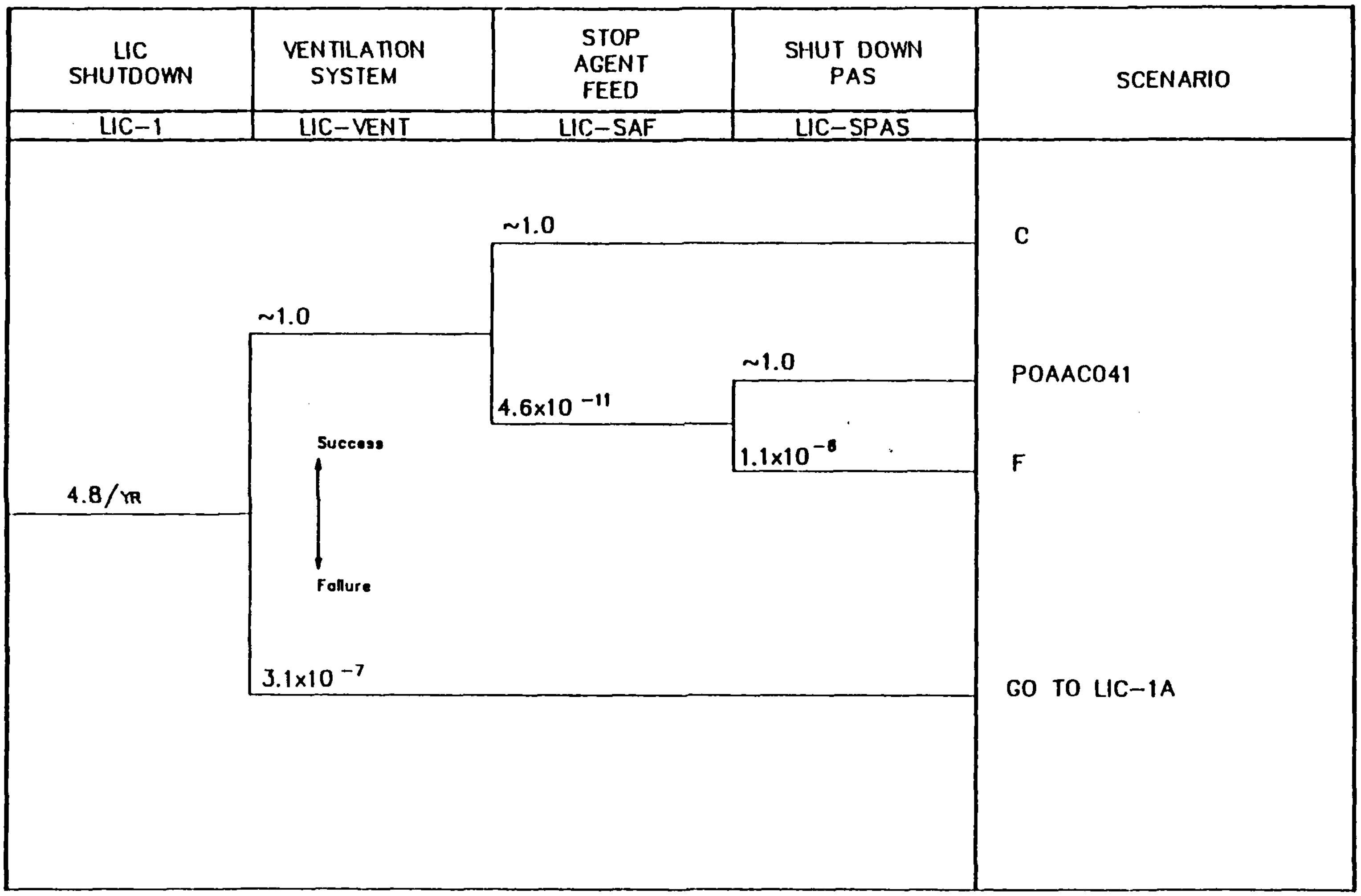


Fig. 7-13. Event tree for LIC-1 initiators

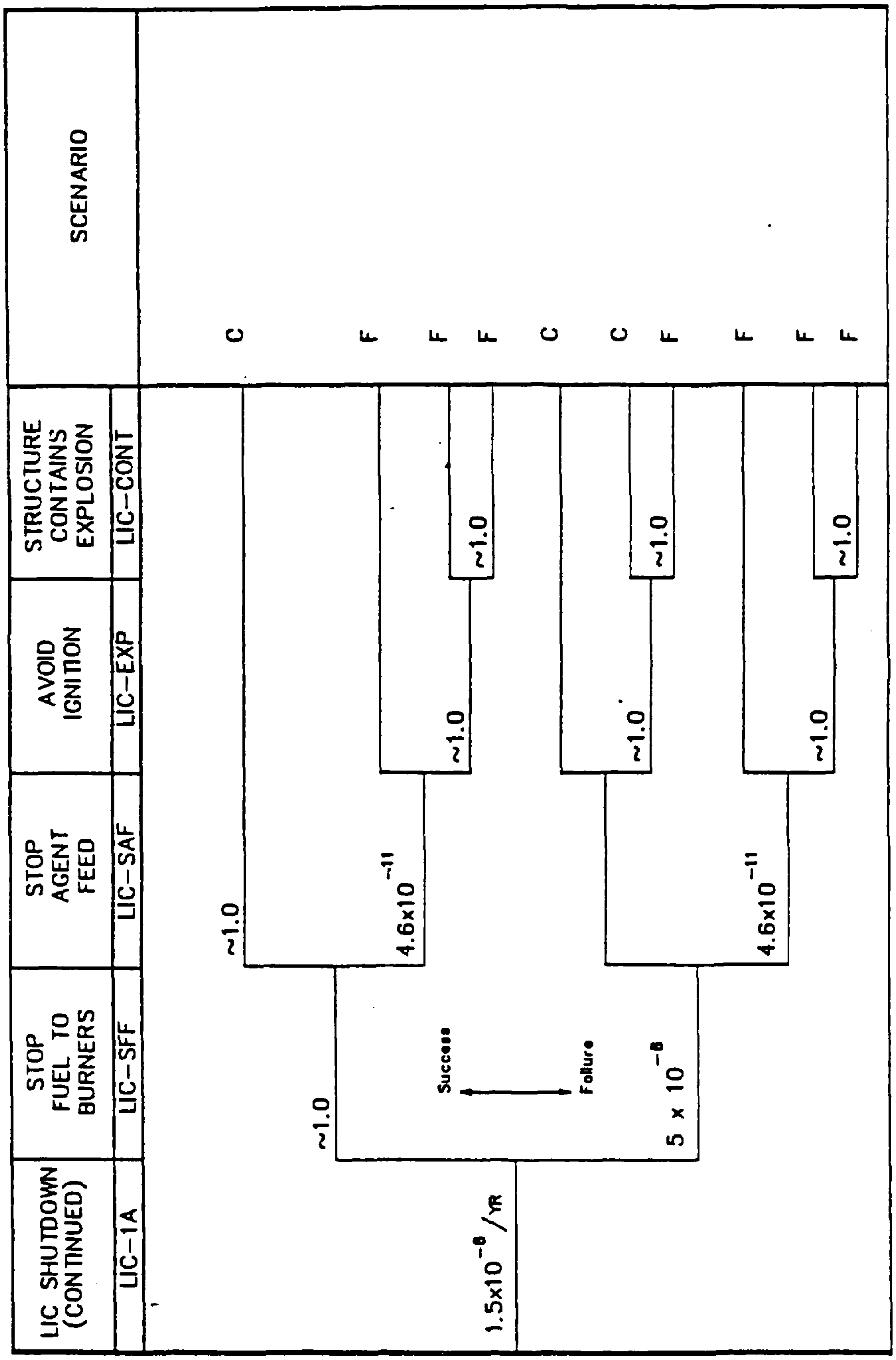


Fig. 7-14. Event tree for LIC-1A initiators

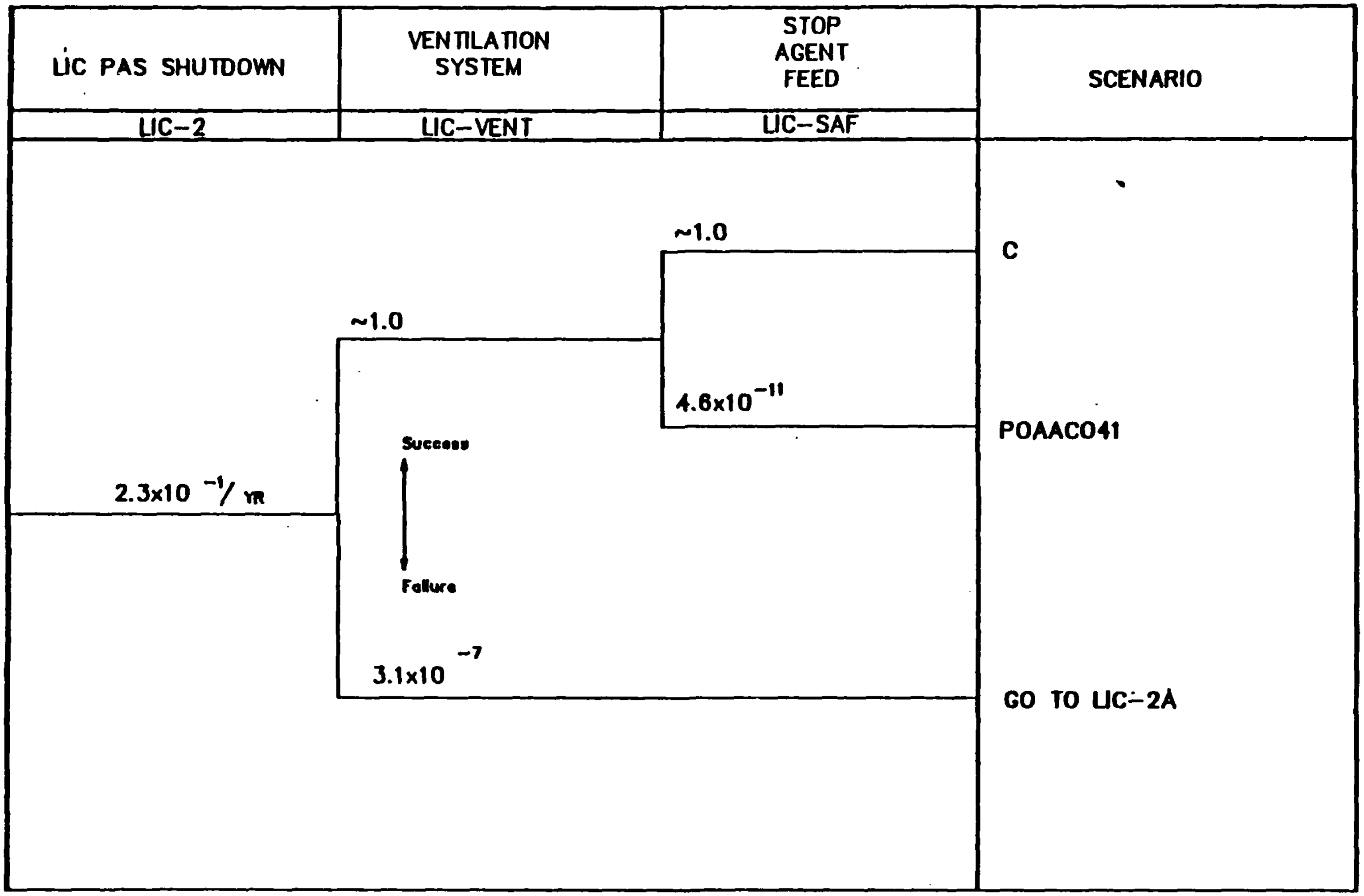


Fig. 7-15. Event tree for LIC-2 initiators

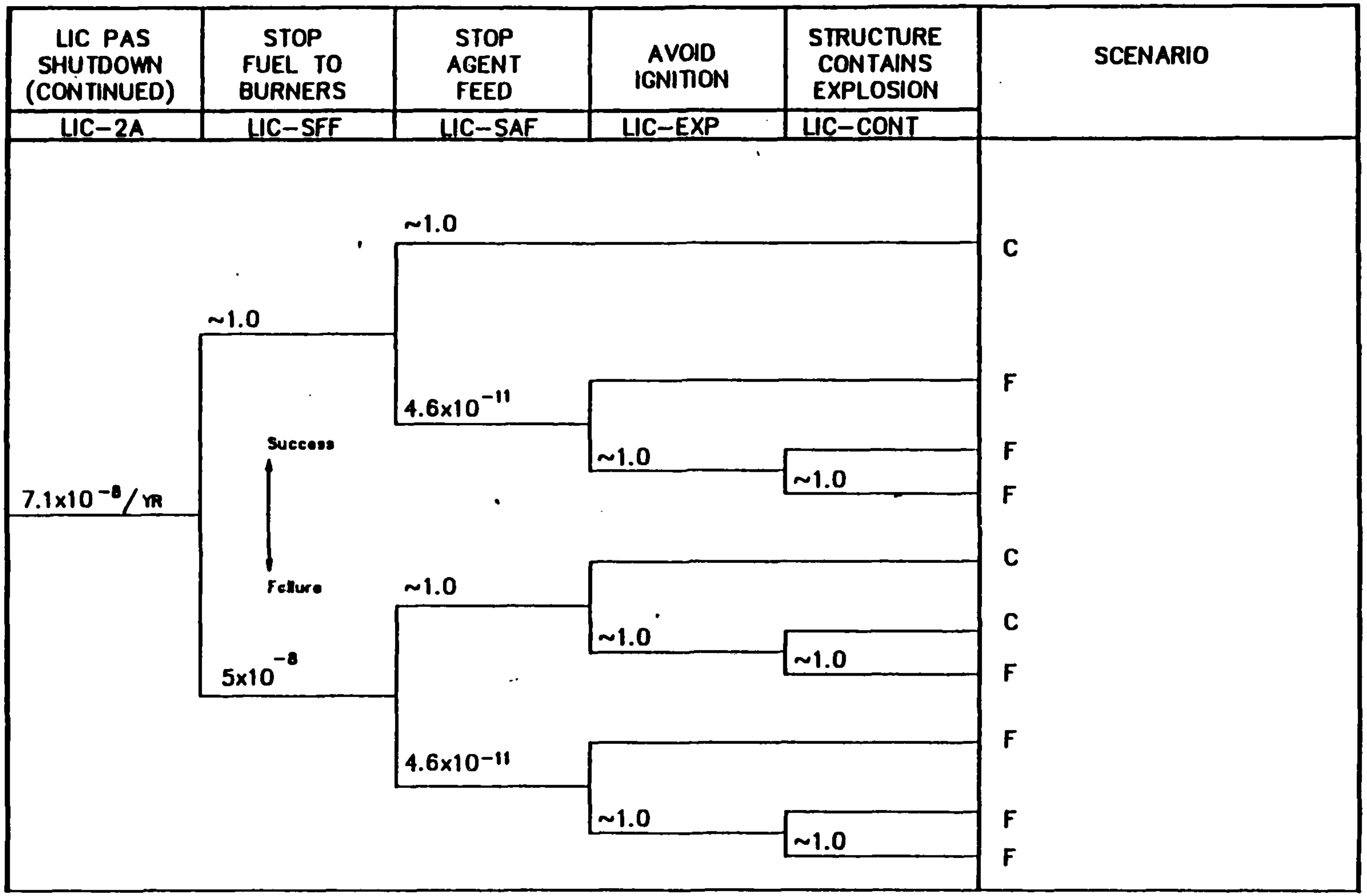


Fig. 7-16. Event tree for LIC-2A initiators

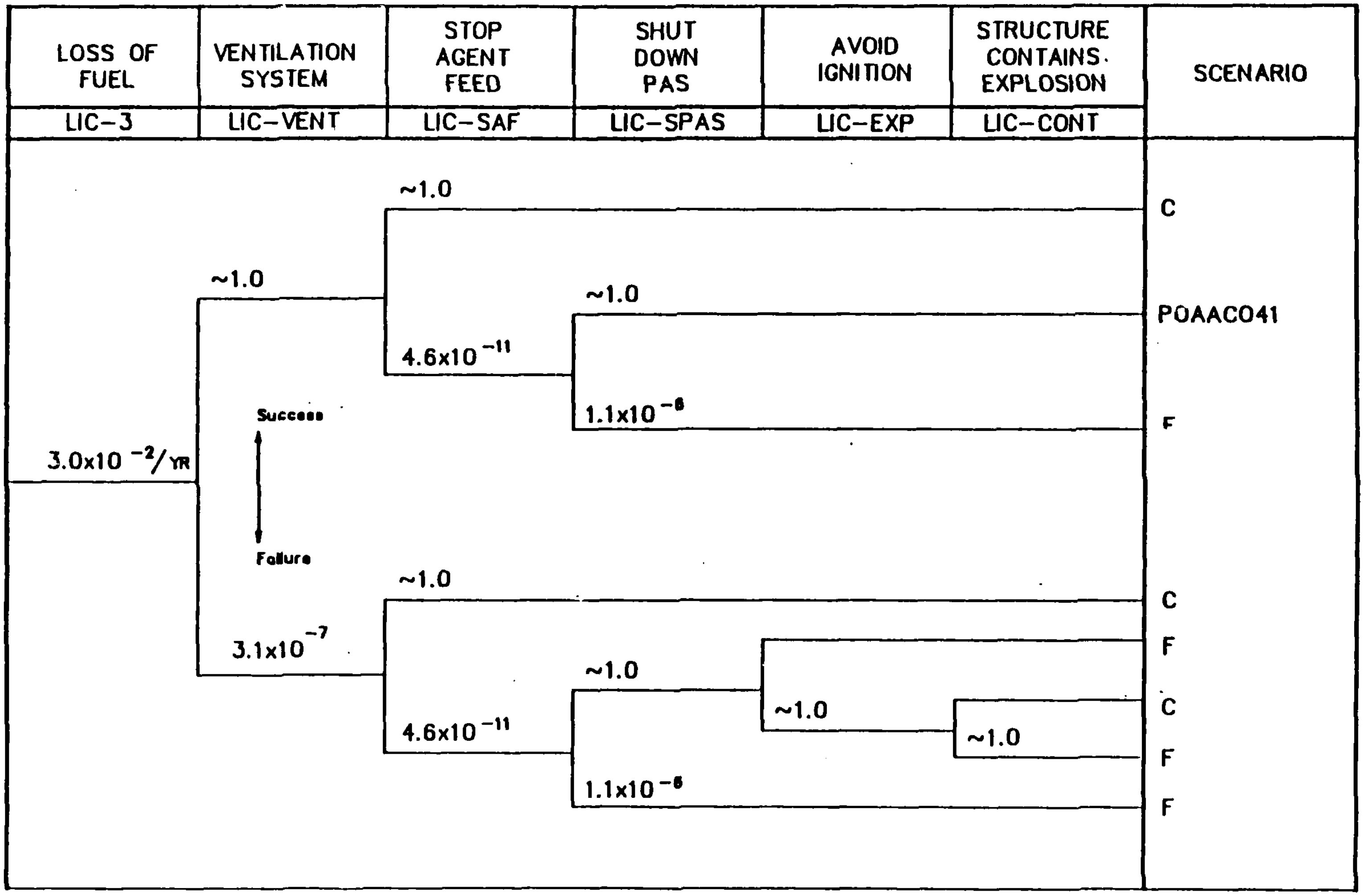


Fig. 7-17. Event tree for LIC-3 initiators

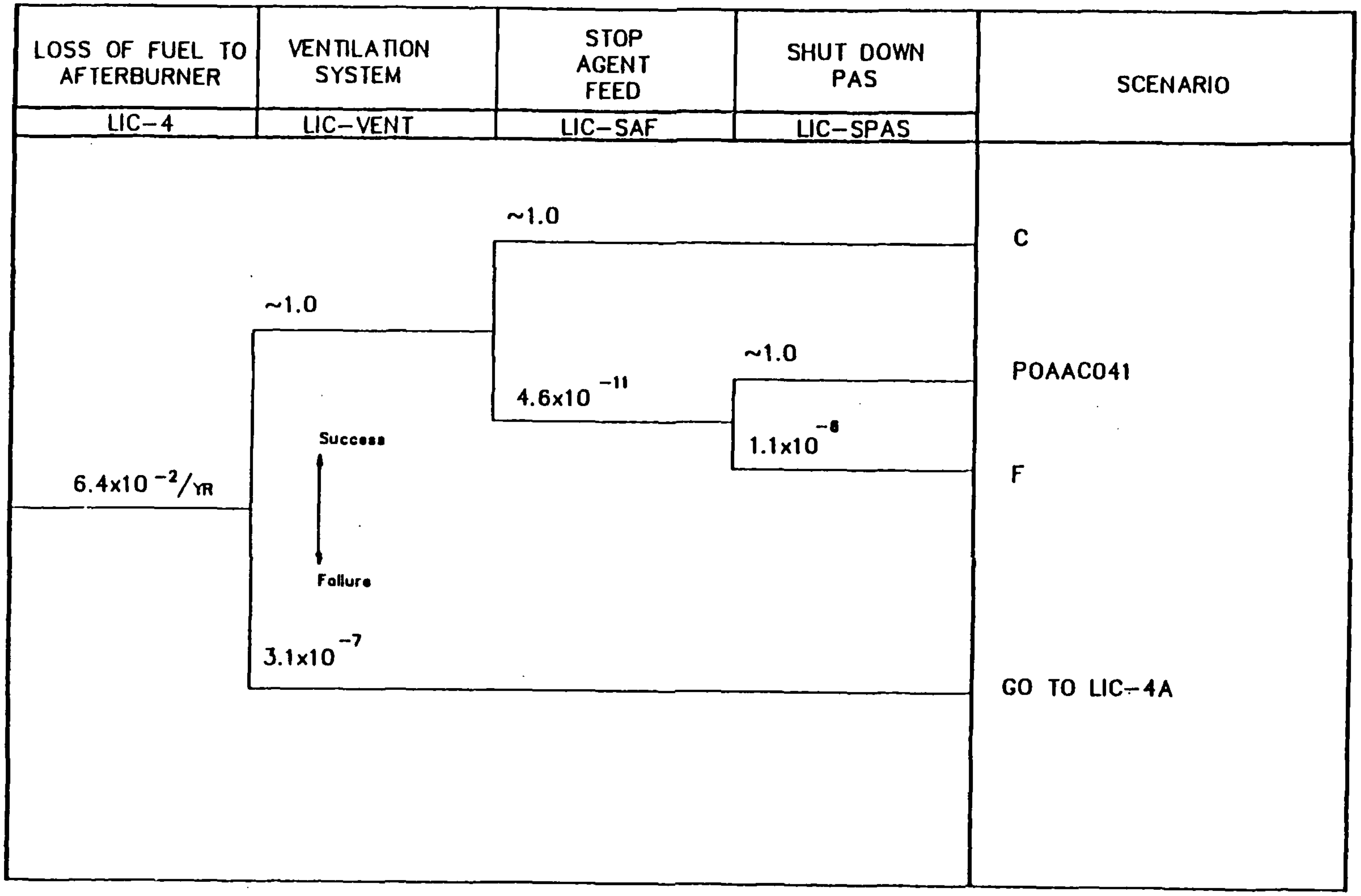


Fig. 7-18. Event tree for LIC-4 initiators

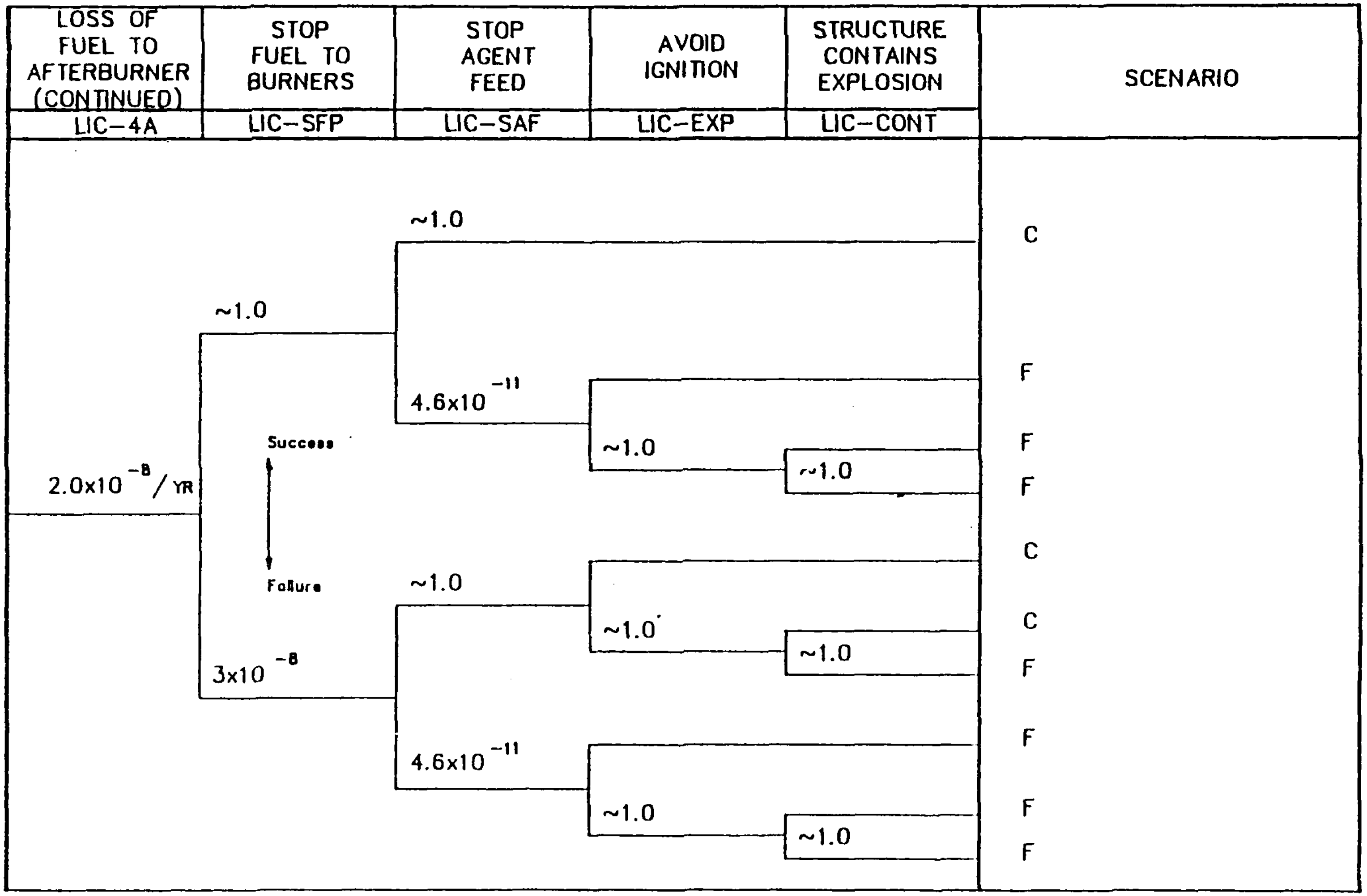


Fig. 7-19. Event tree for LIC-4A initiators

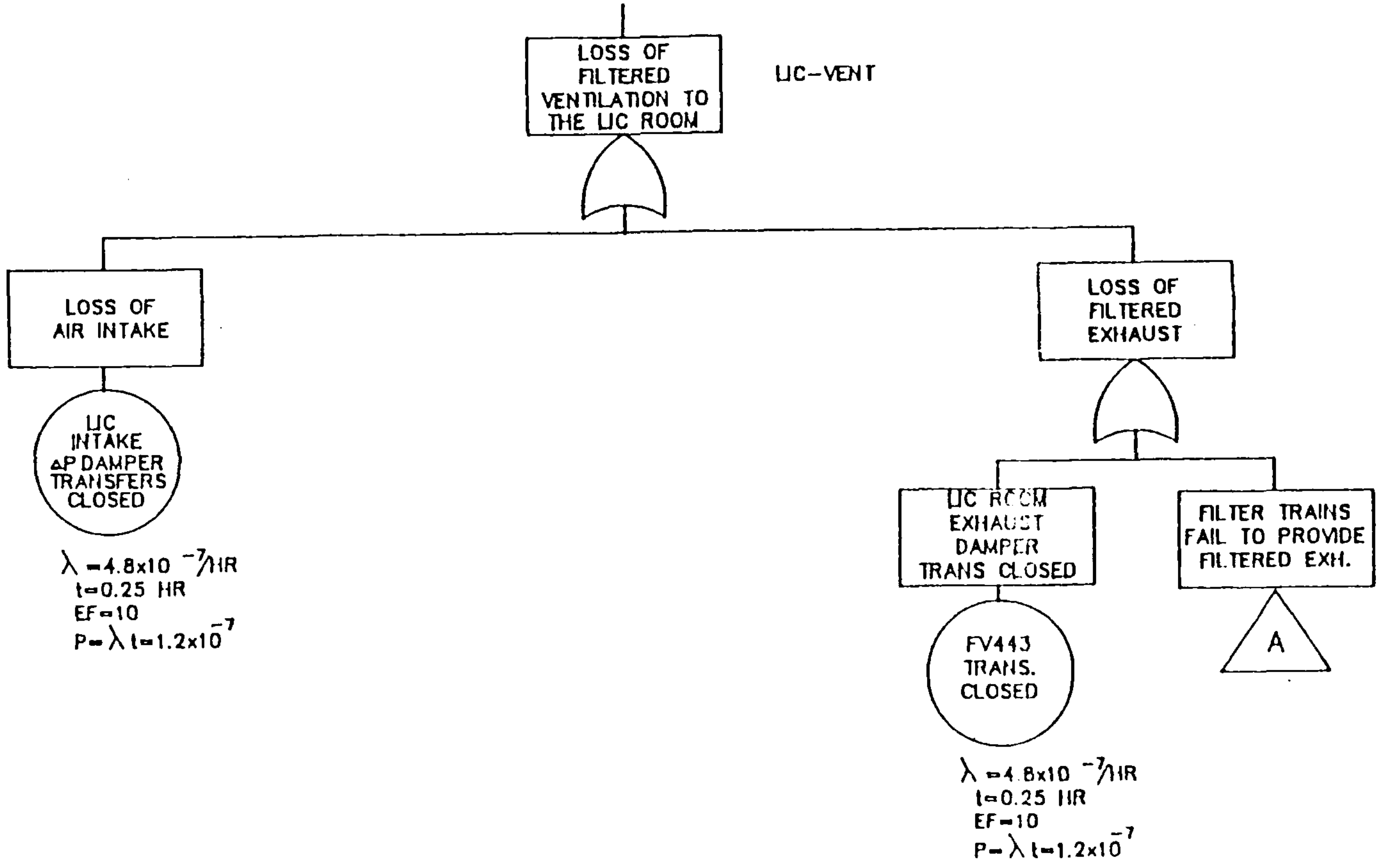


Fig. 7-20. LIC room ventilation fault trec

7-41

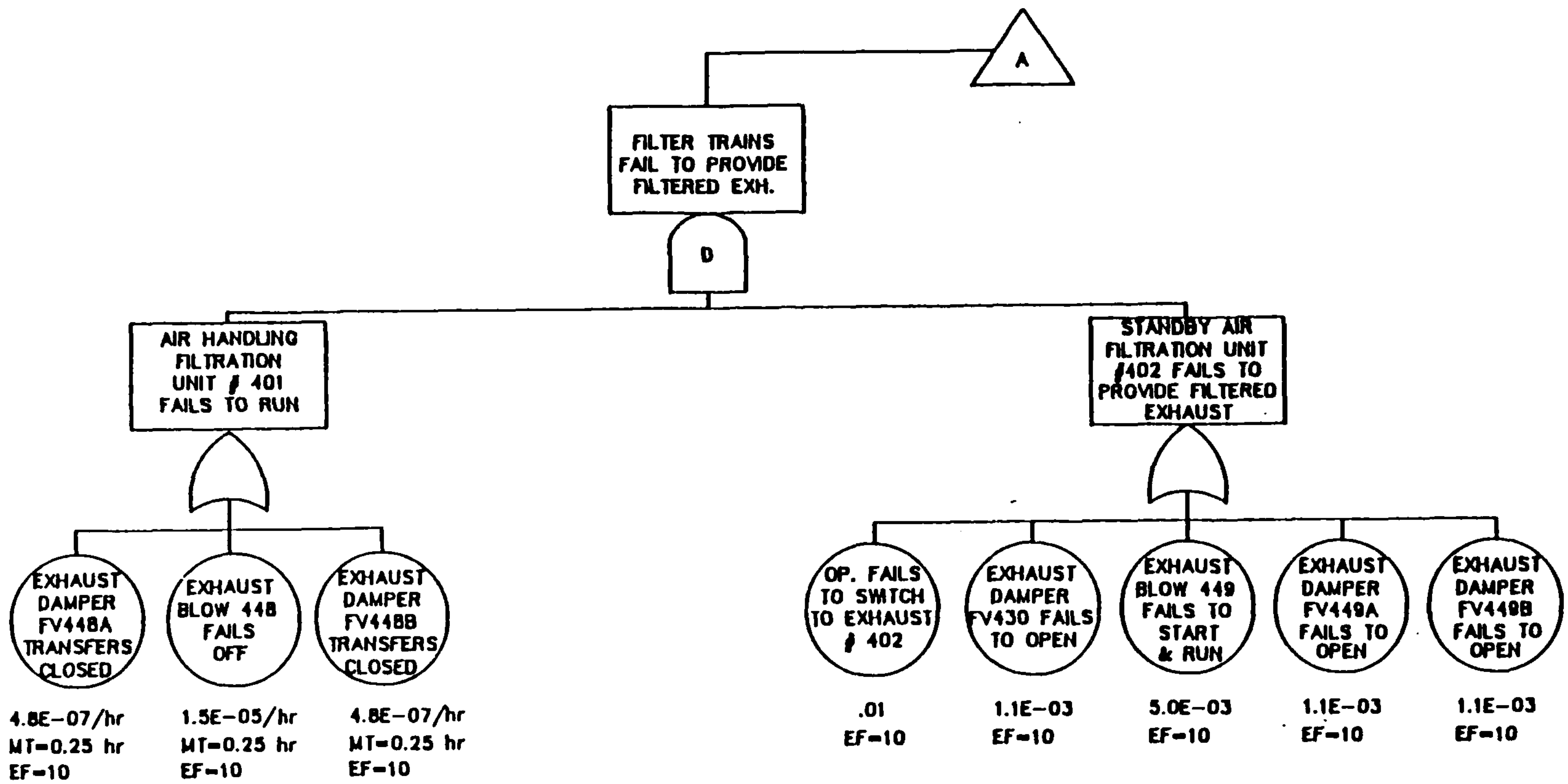


Fig. 7-21. Filtered exhaust fault tree

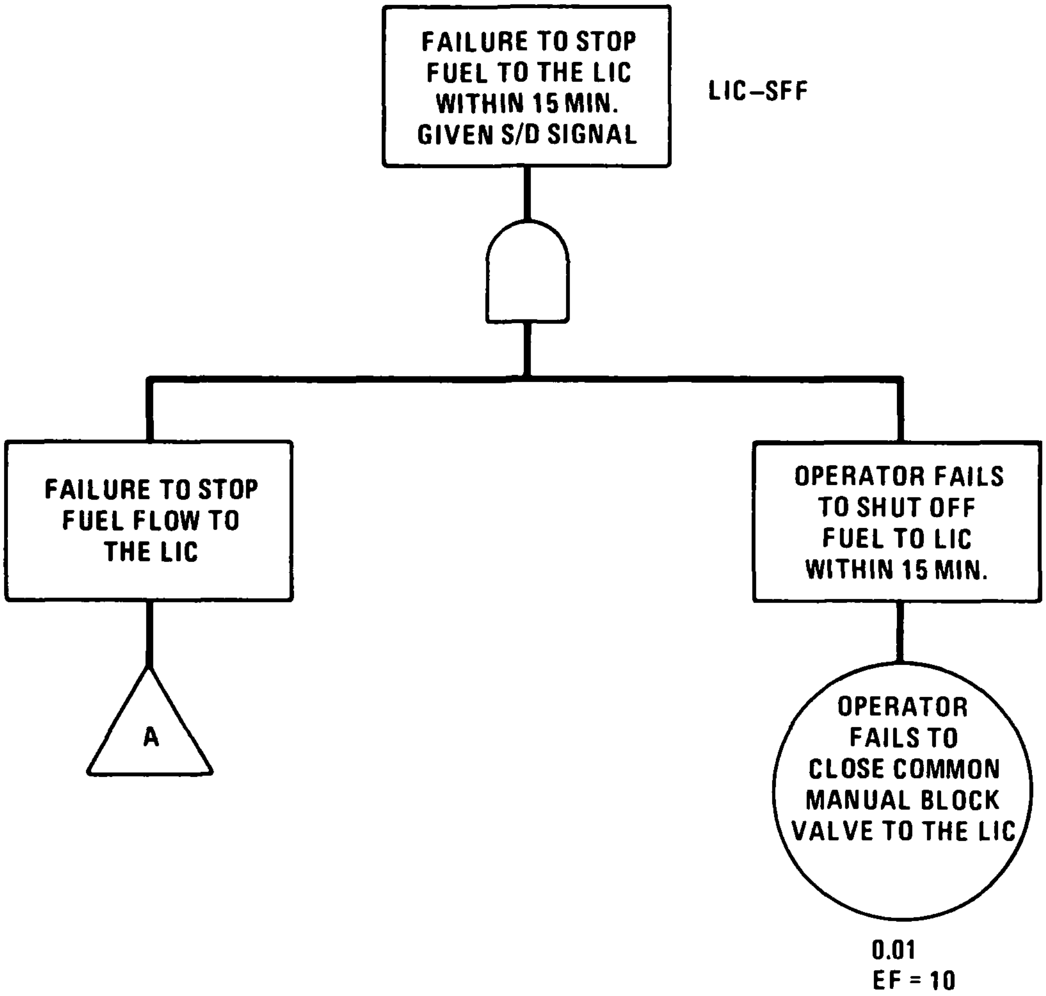


Fig. 7-22. Fault tree for LIC fuel flow termination

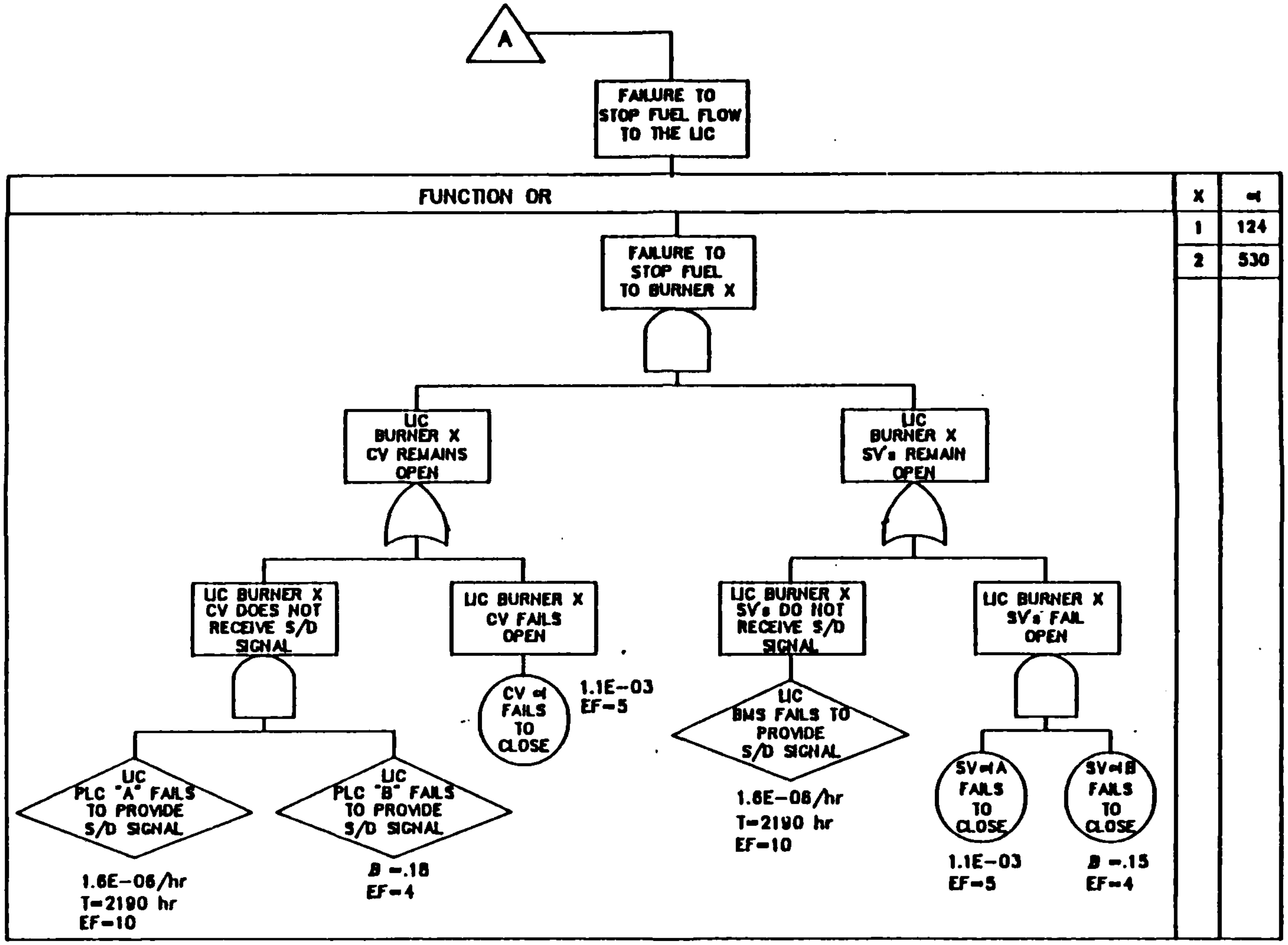


Fig. 7-23. Fault tree for terminating fuel flow to LIC burners

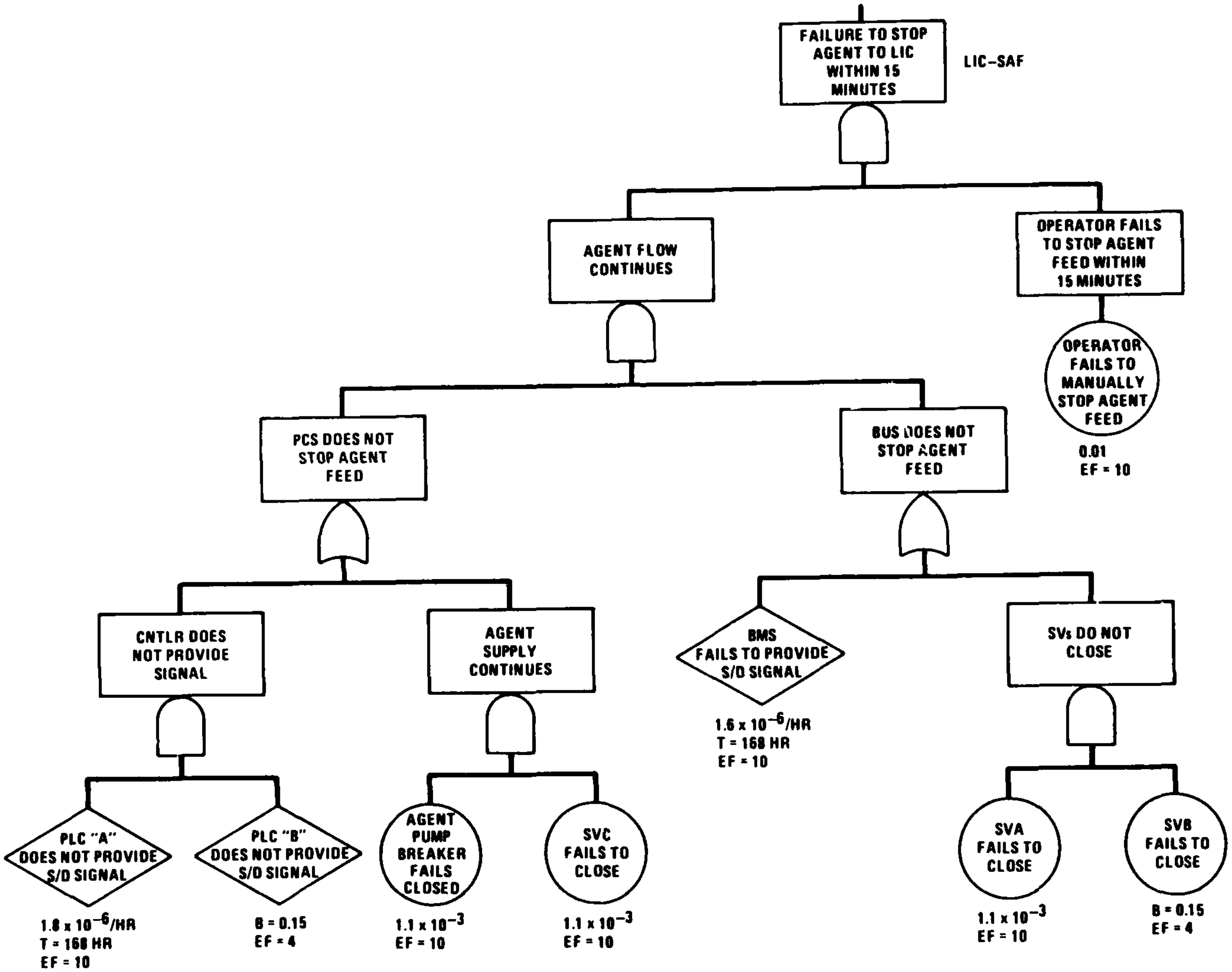


Fig. 7-24. Fault tree for LIC agent feed termination

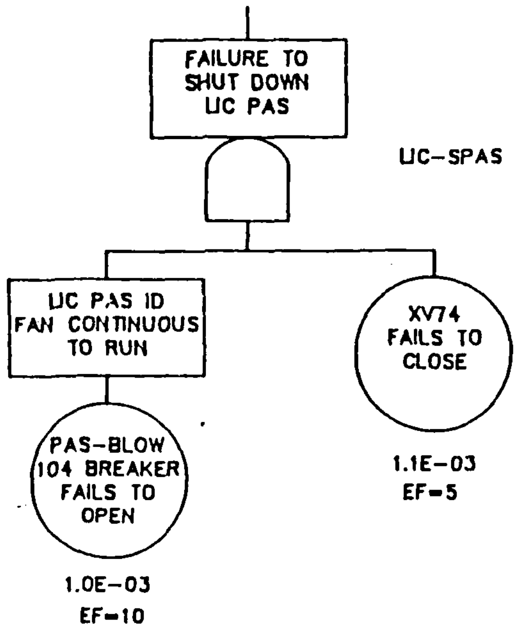


Fig. 7-25. Fault tree for LIC PAS shutdown

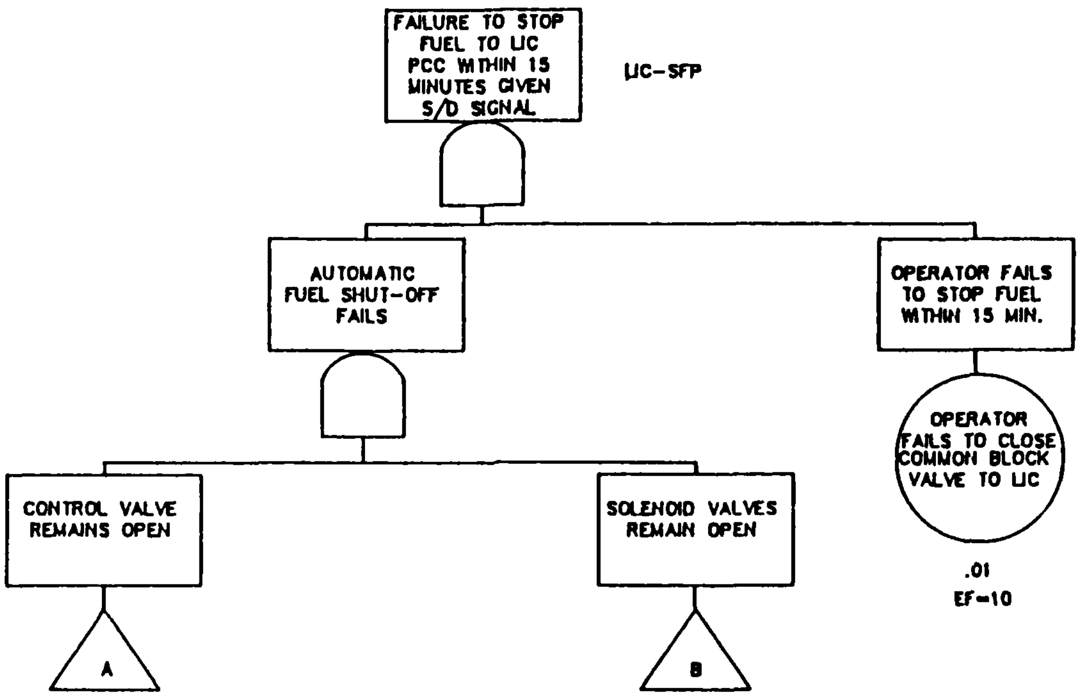


Fig. 7-26. Fault tree for LIC PCC fuel flow termination

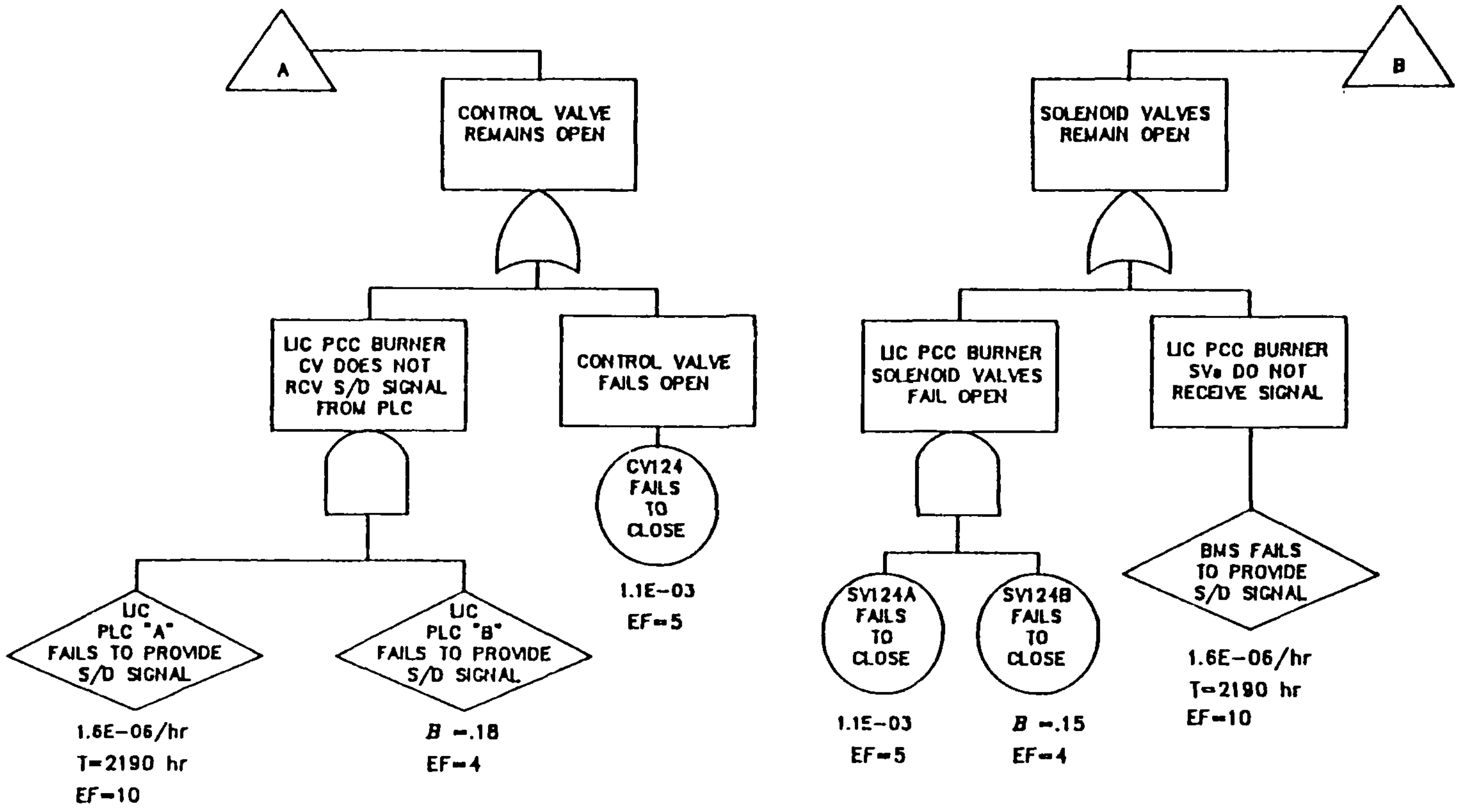


Fig. 7-27. Control and solenoid valve fault trees

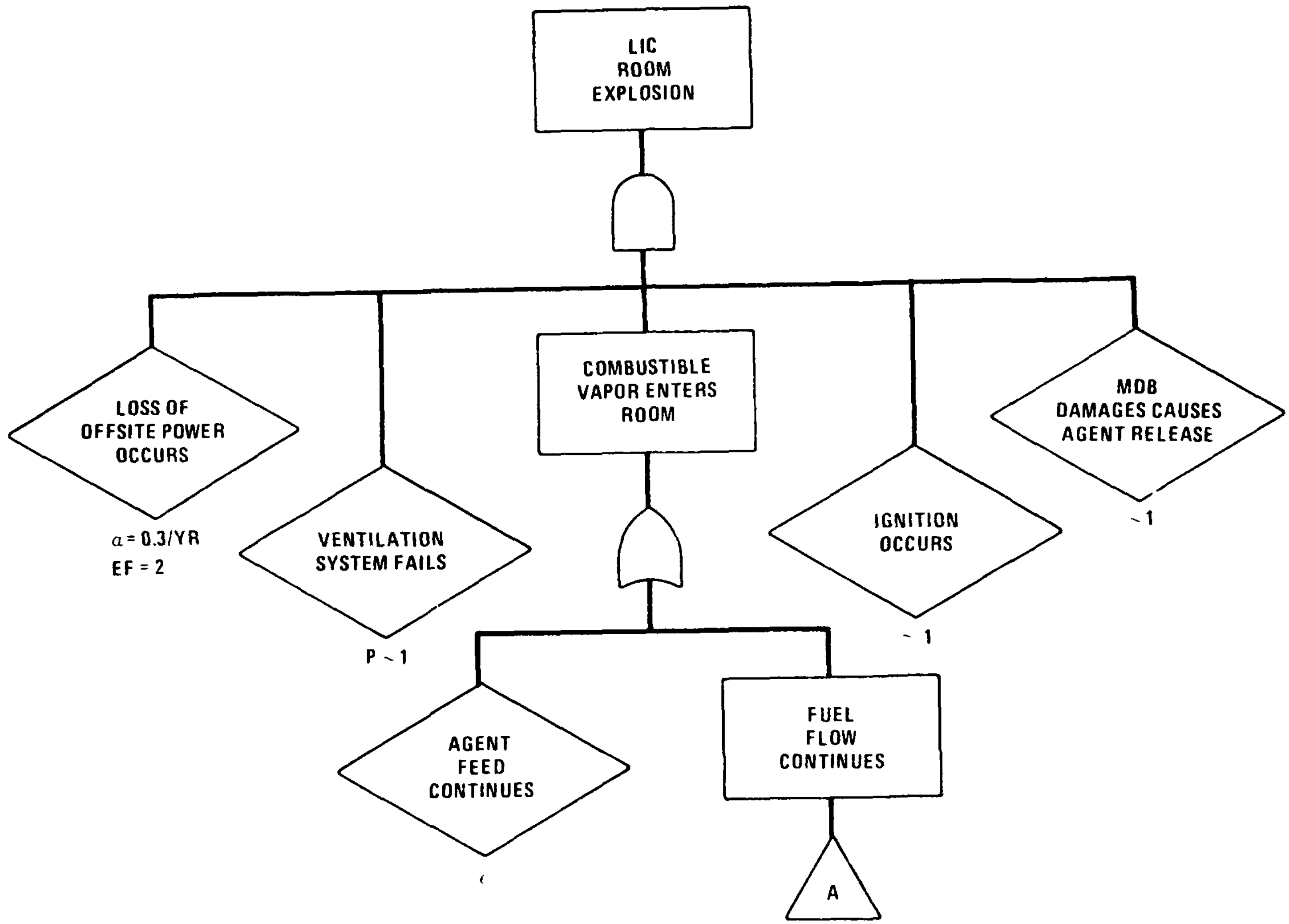


Fig. 7-28. LIC room explosion fault tree

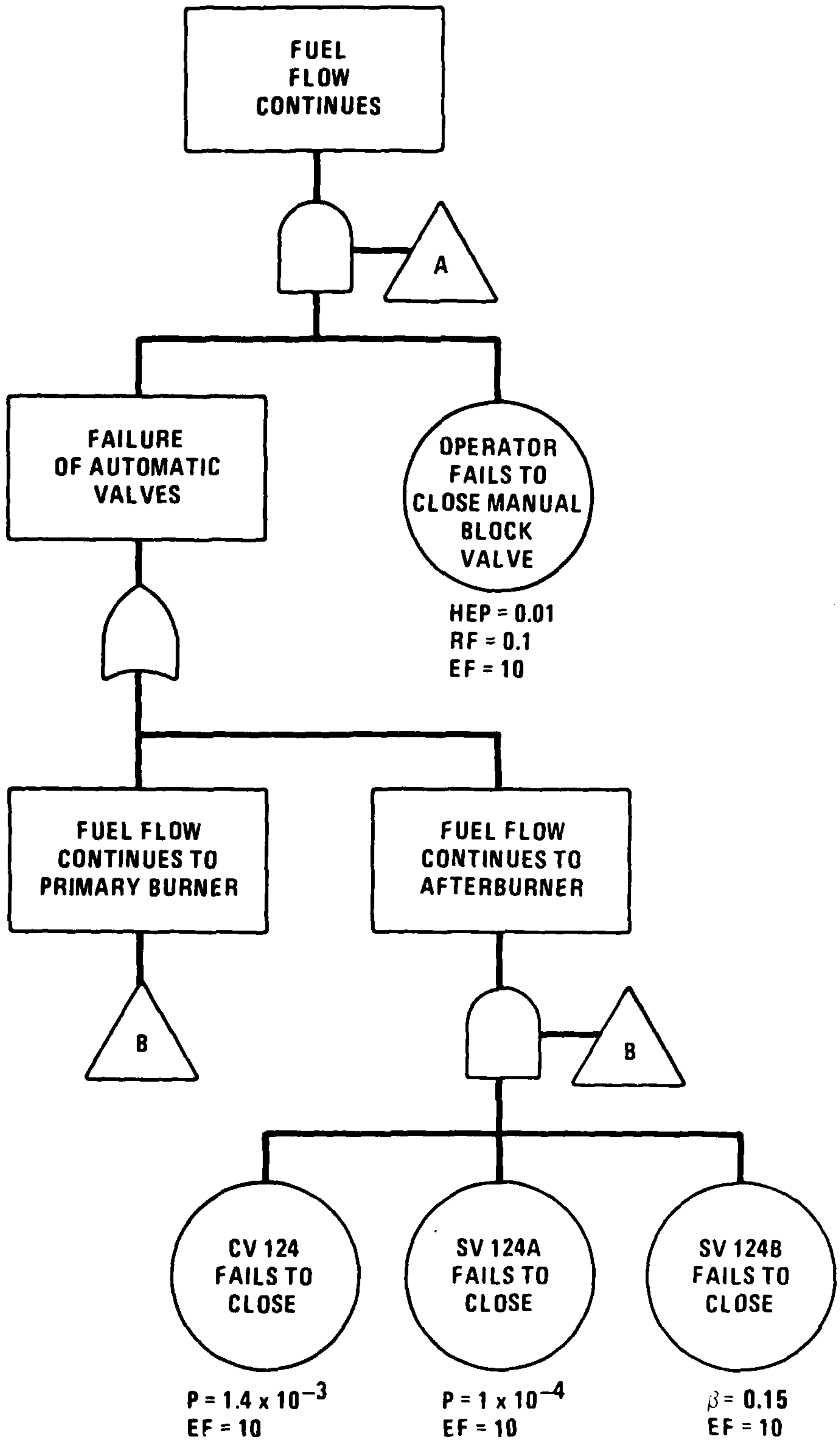


Fig. 7-29. Fault tree for fuel flow forming a flammable mixture in the LIC room

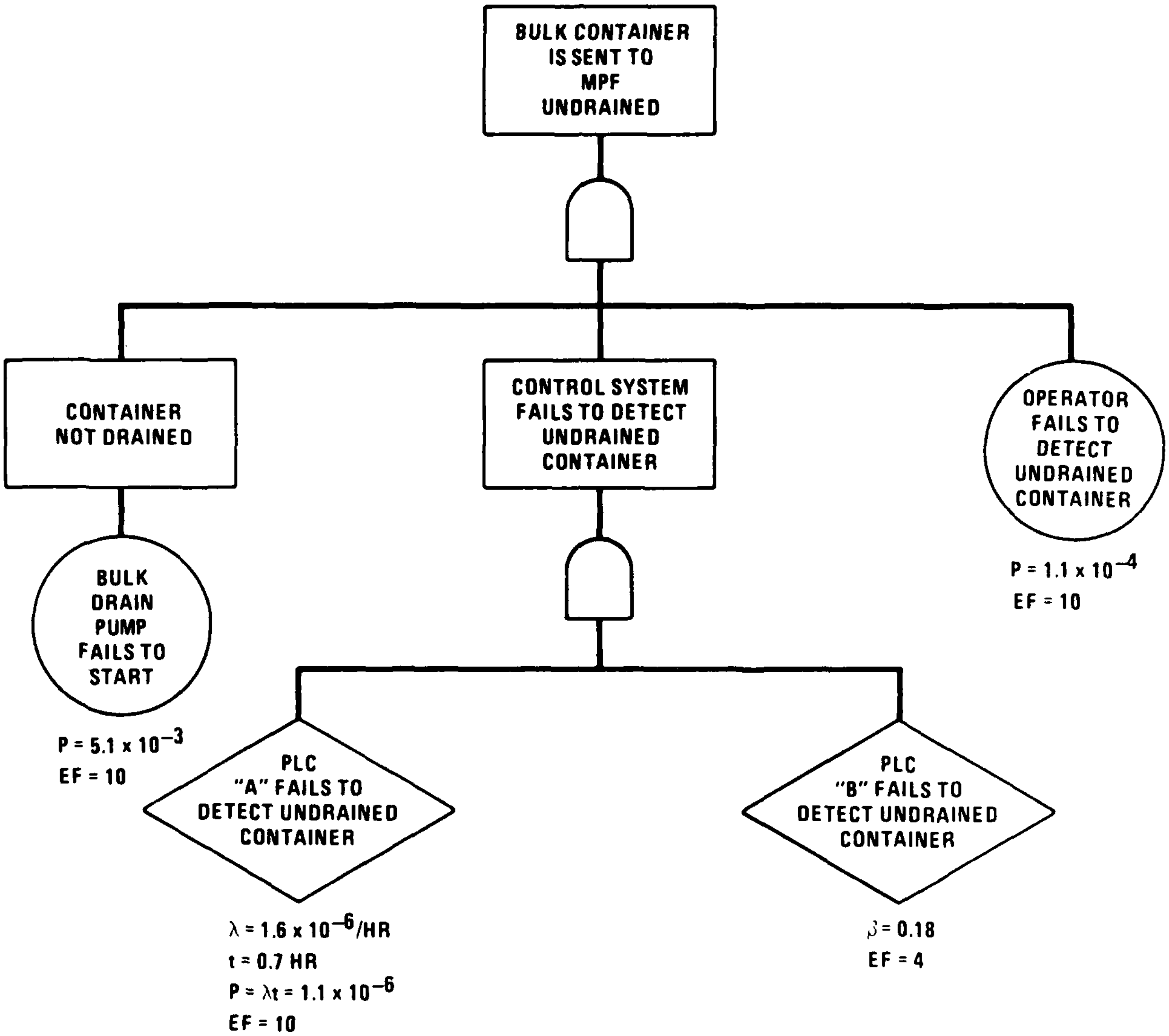


Fig. 7-30. Fault tree for draining bulk containers

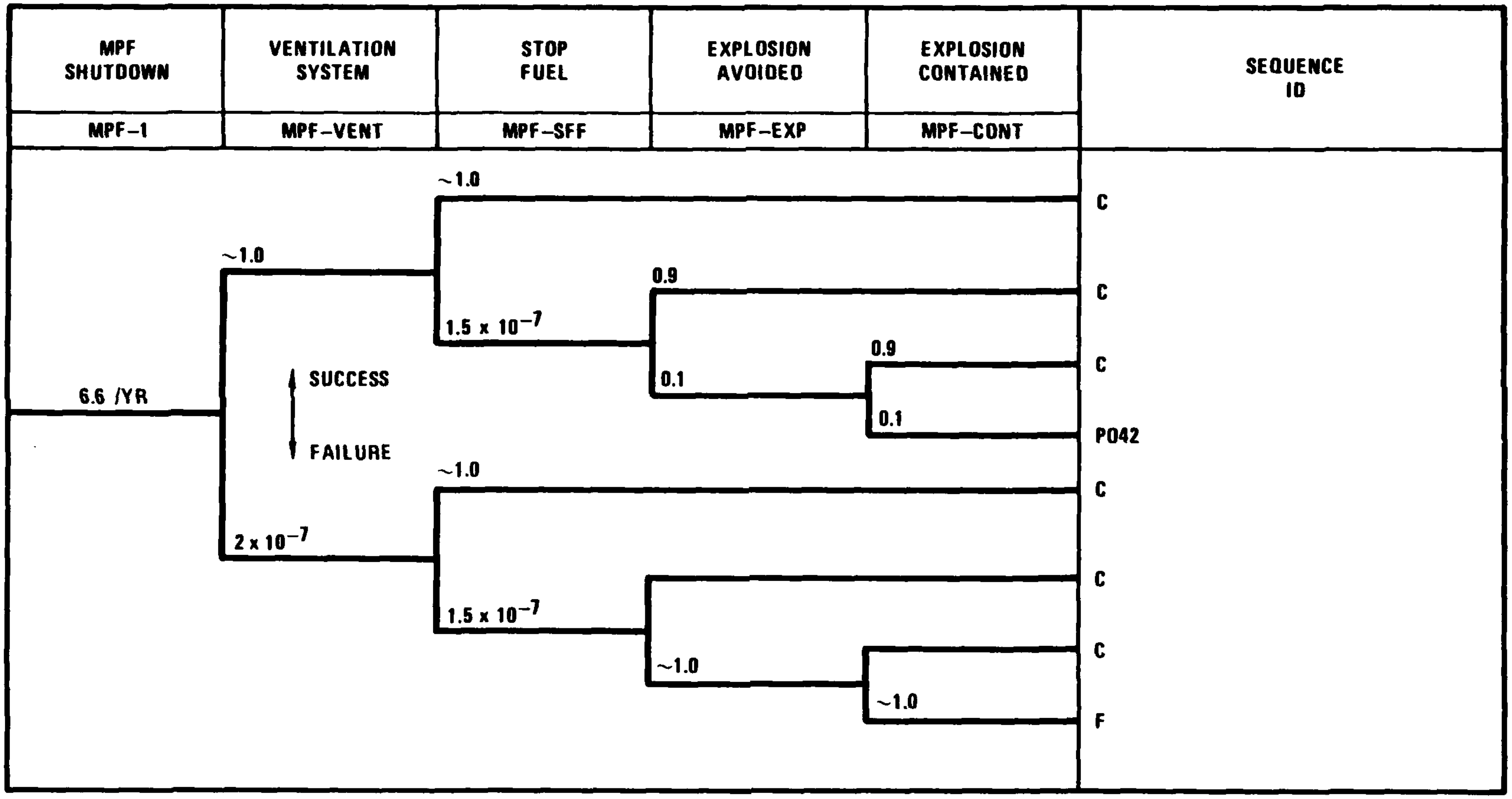


Fig. 7-31. Event tree for MPF shutdown

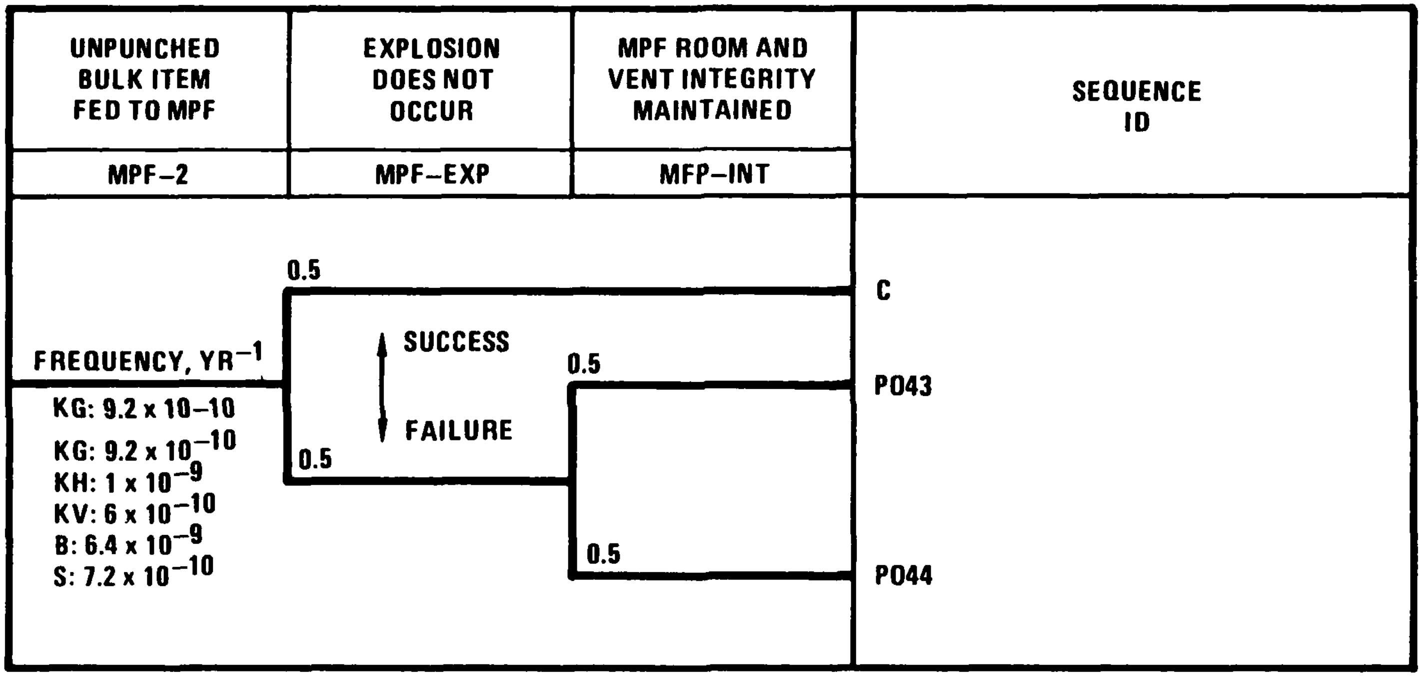


Fig. 7-32. Event tree for unpunched bulk item fed to MPF

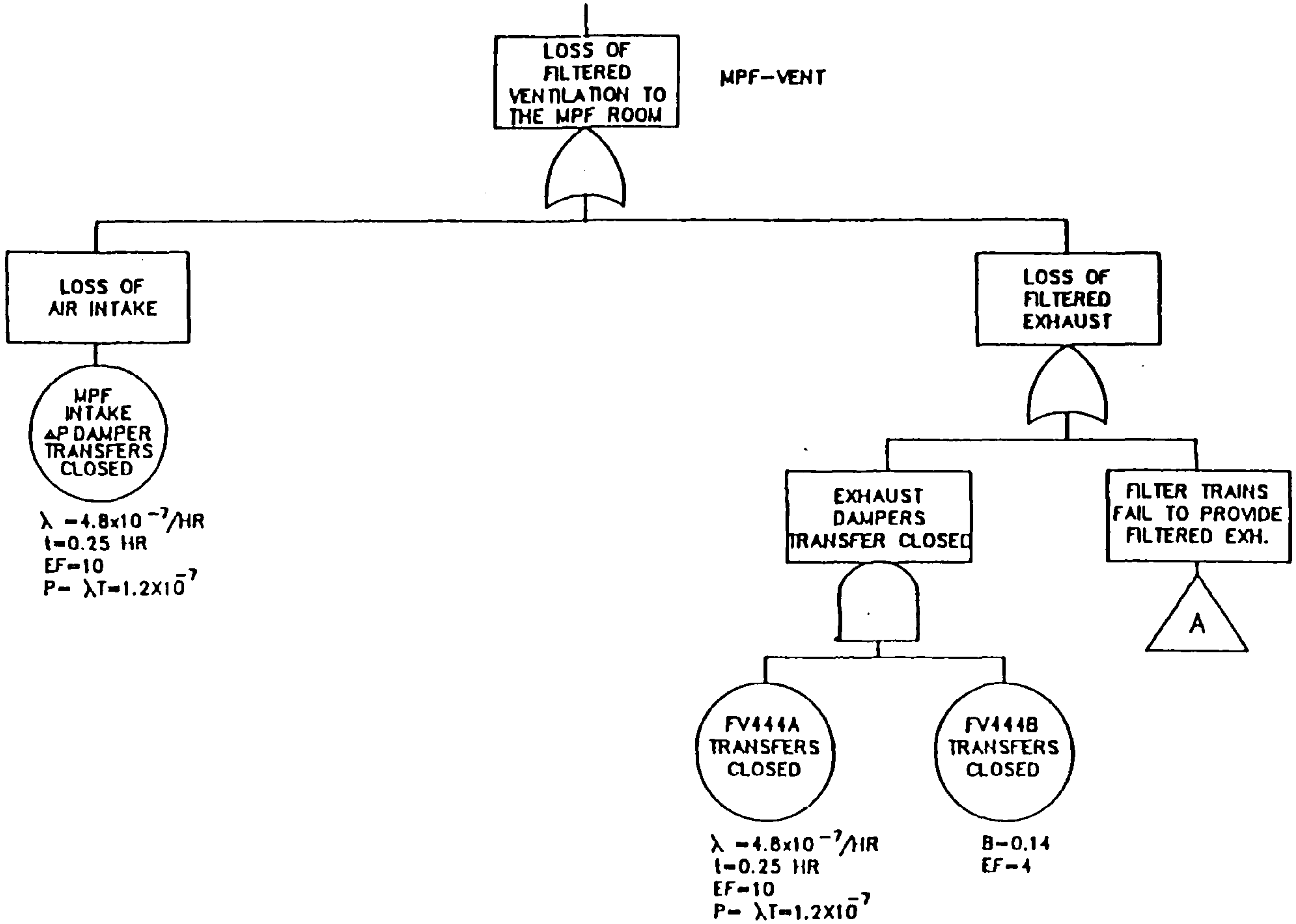


Fig. 7-33. MPF room ventilation fault tree

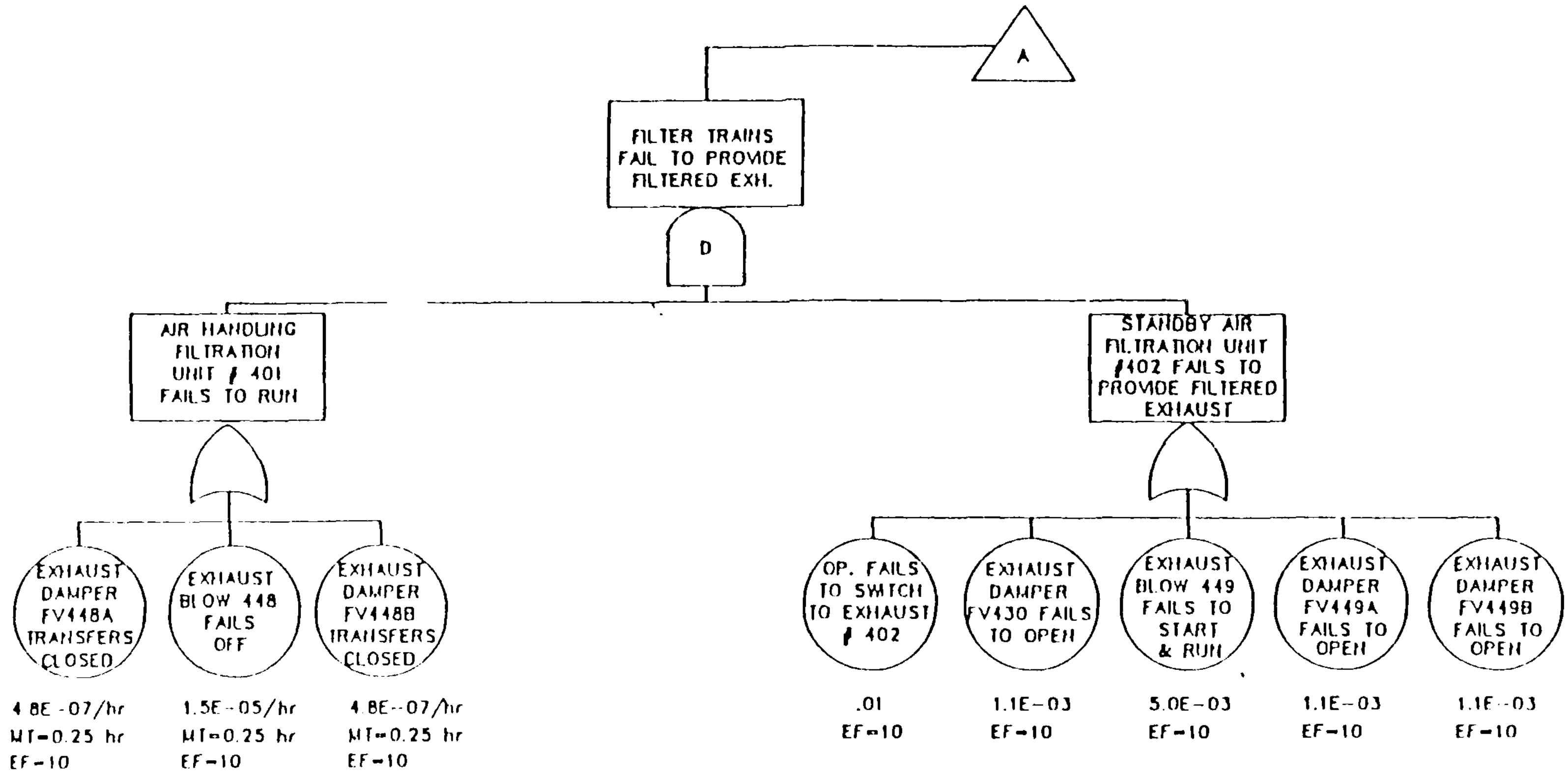


Fig. 7-34. MPF room filtered exhaust fault tree

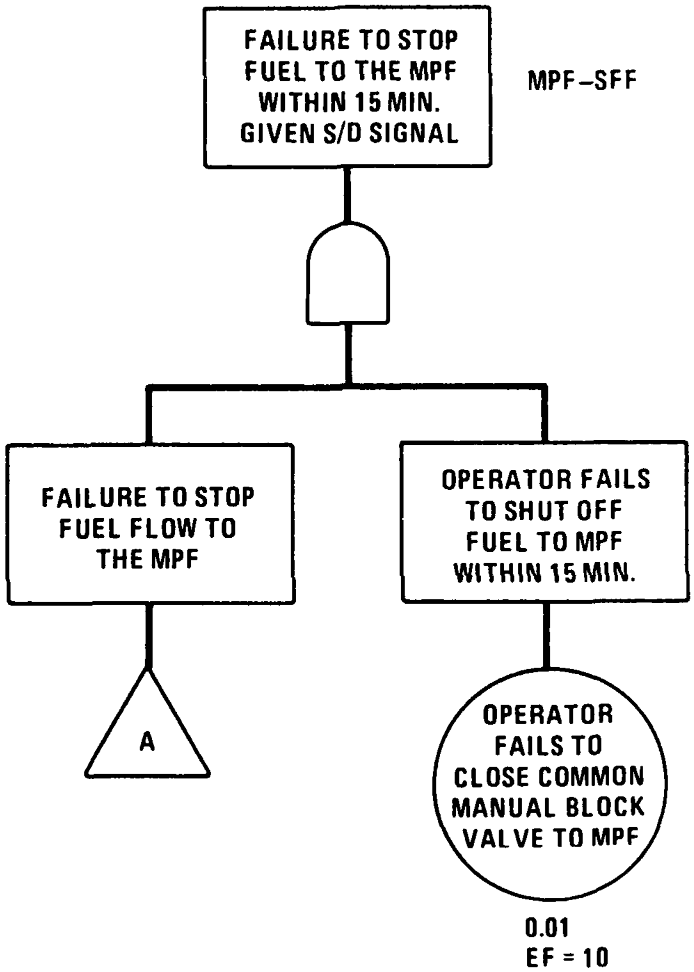
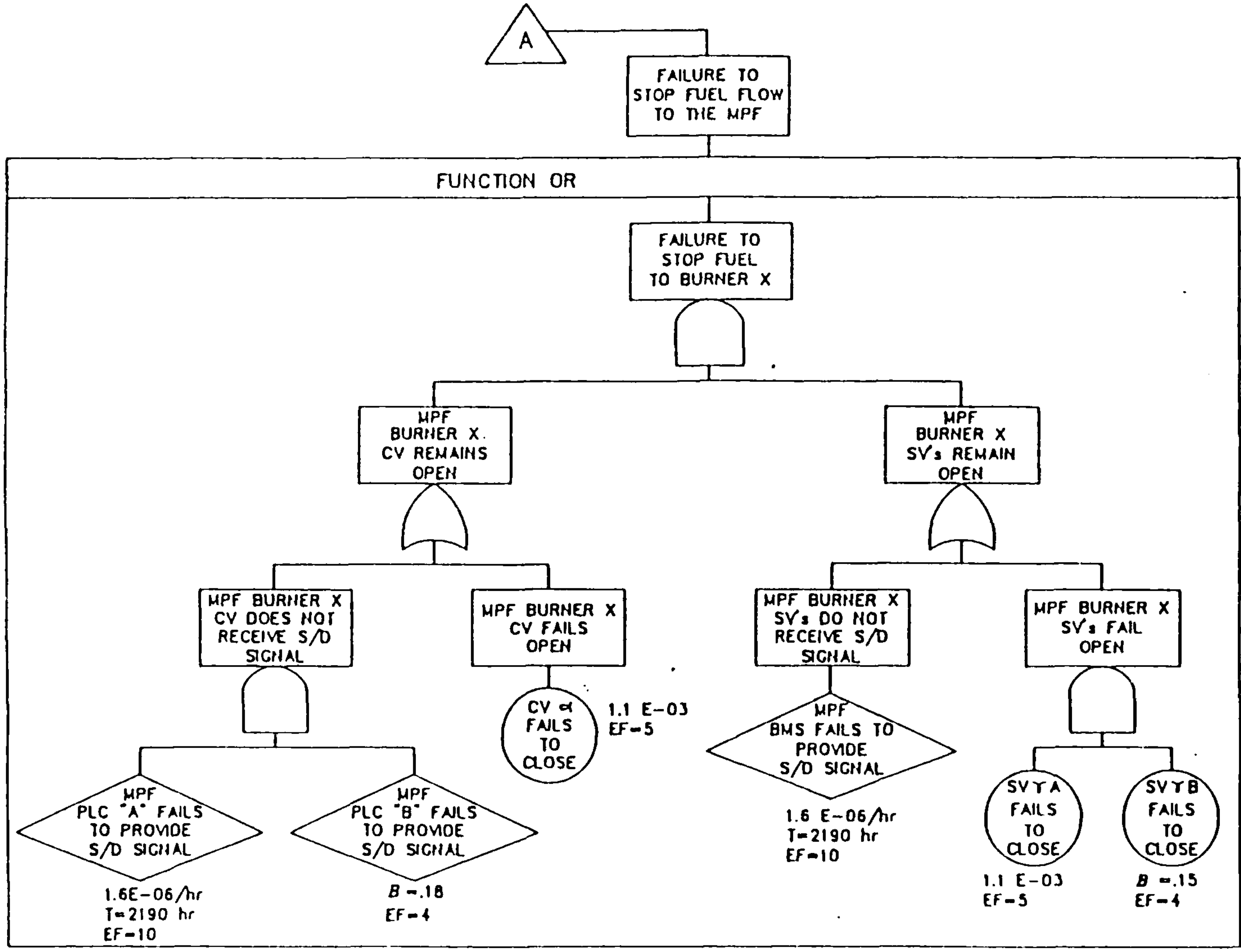


Fig. 7-35. Fault tree for MPF fuel flow termination



X	α	γ
1	166	167
2	186	187
3	206	207
4	226	227
5	246	247
6	266	267
7	46	47
8	67	68
9	106	107
10	126	127

Fig. 7-36. Fault tree for failure to stop fuel to MPF burners

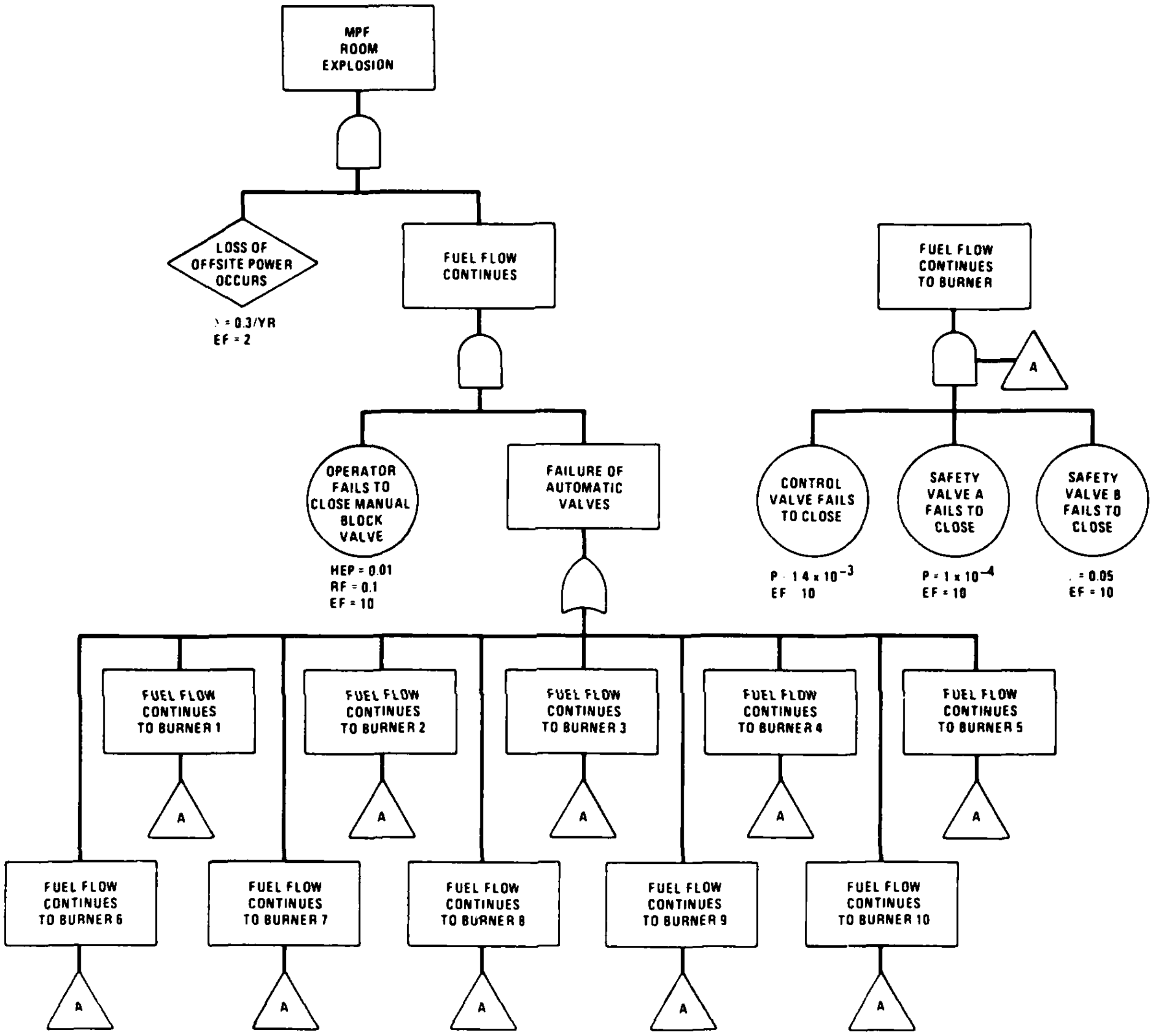


Fig. 7-37. MPF room explosion fault tree (loss of offsite power)

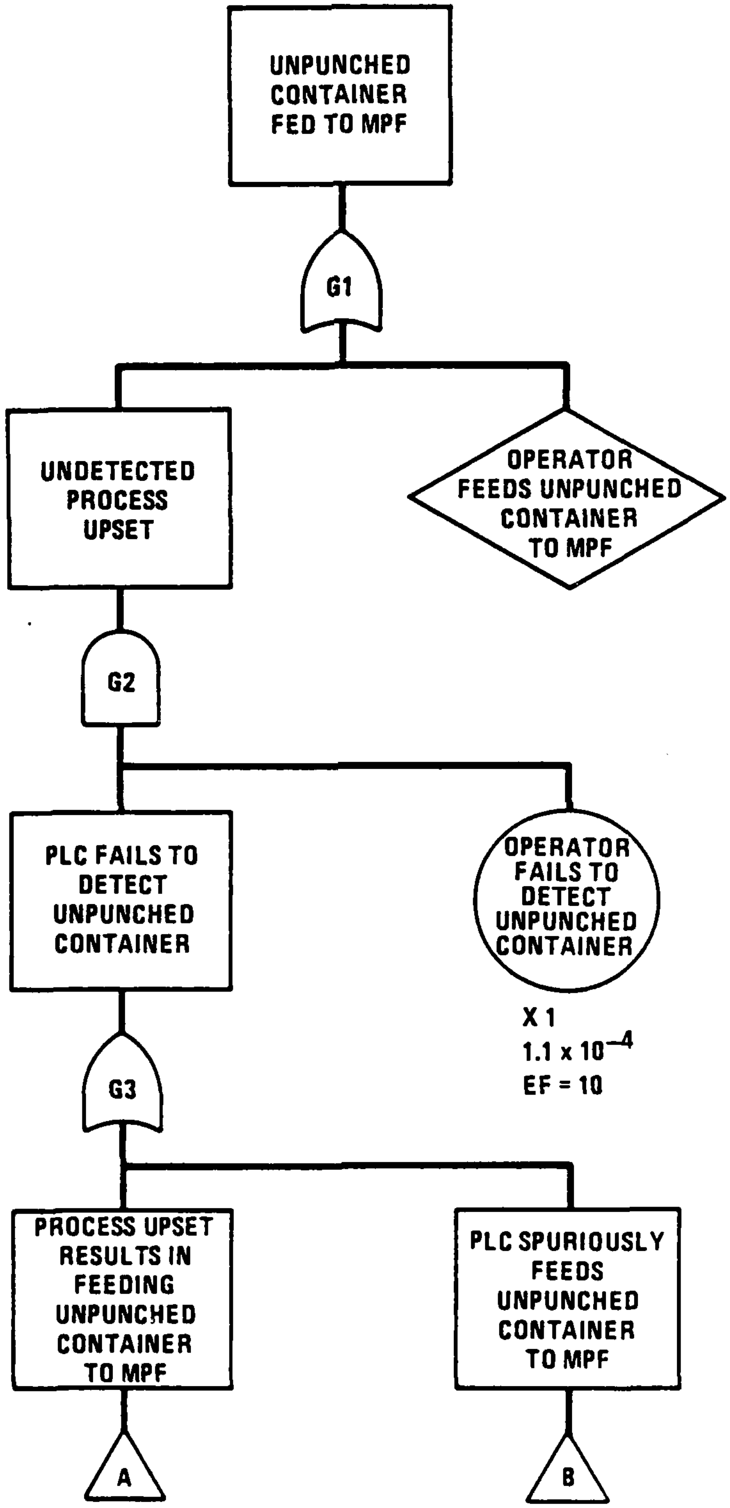


Fig. 7-38. Fault tree for feeding an unpunched container to the MPF (sheet 1 of 4)

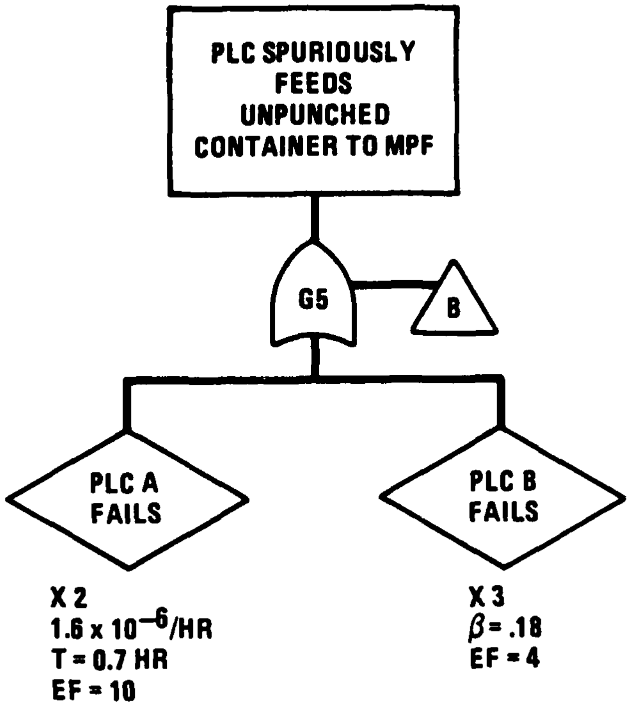


Fig. 7-38. Fault tree for feeding an unpunched container to the MPF (sheet 2 of 4)

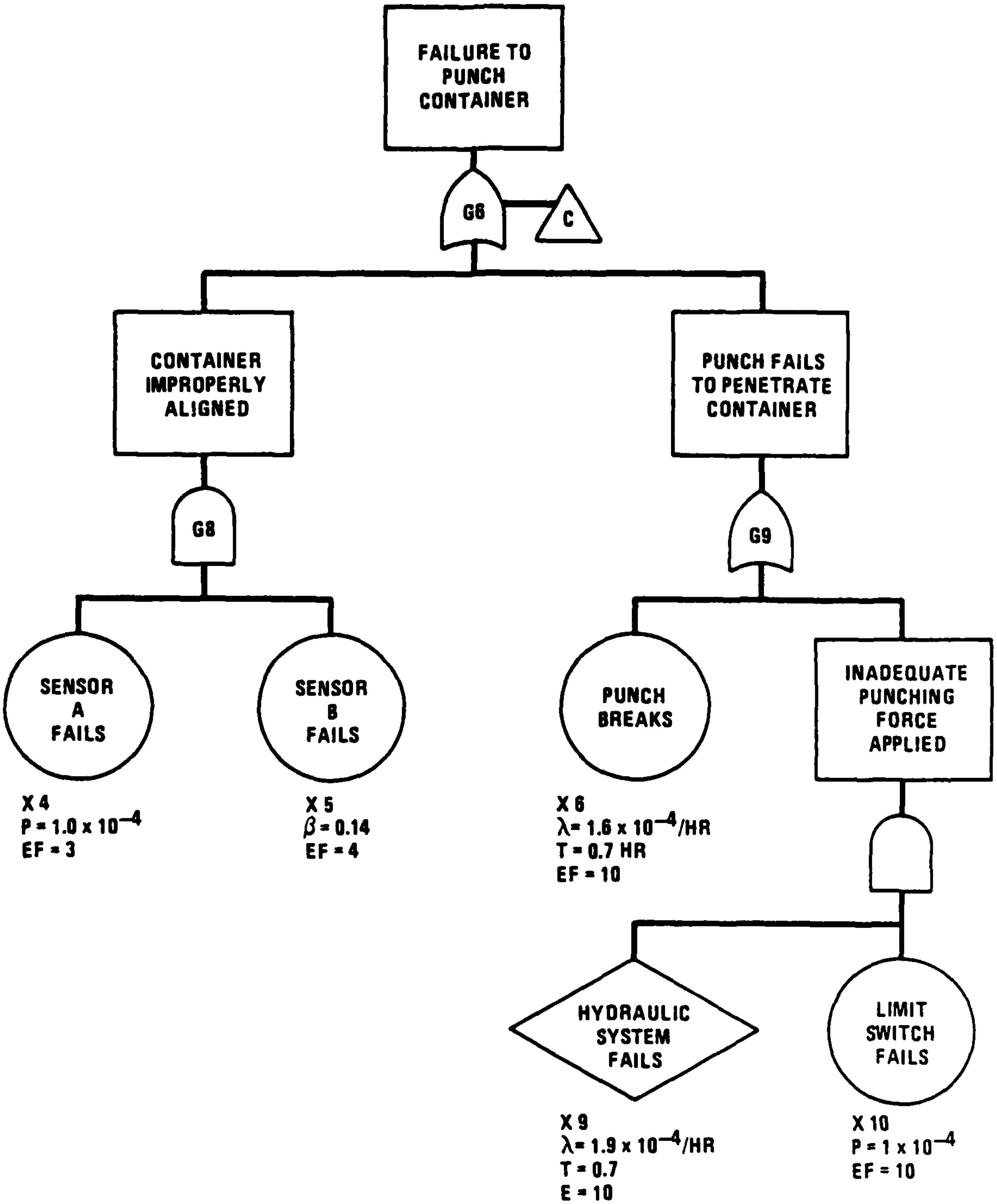


Fig. 7-38. Fault tree for feeding an unpunched container to the MPF (sheet 3 of 4)

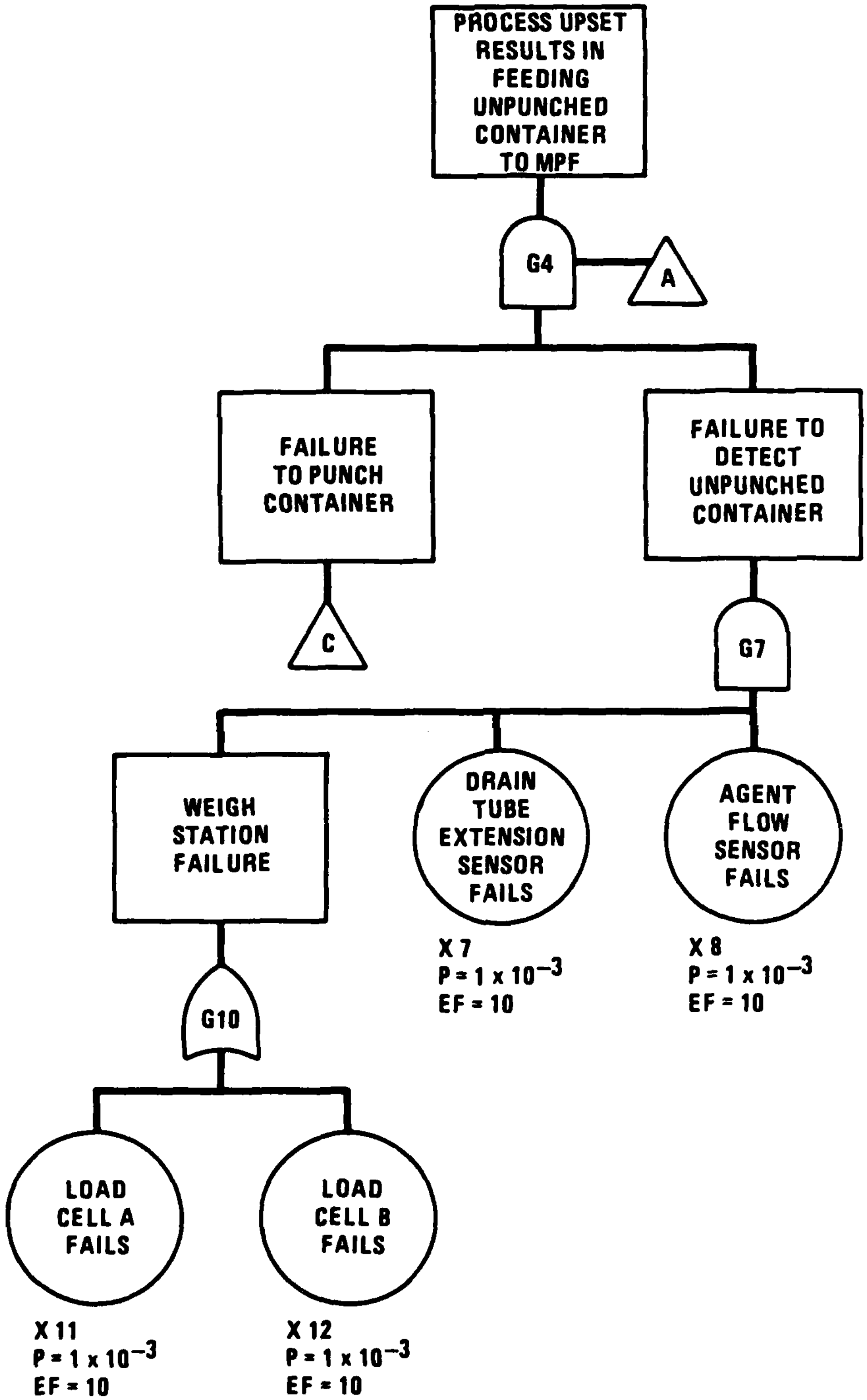


Fig. 7-38. Fault tree for feeding an unpunched container to the MPF (sheet 4 of 4)

The probability that the operators mistakenly leave a mine in the dunnage box involves two operator errors, one of which is recoverable. First, an operator must inadvertently begin to place a mine in the dunnage box. This human error is estimated to have the probability of 0.01. However, the mine weighs 23 lb, and is of a different shape than the drum packing material. Since the extra weight and shape difference are sensory cues to alert the operator of the initial error, a 0.1 recovery factor (Ref. 7-3) is applied to the initial human error probability. Moreover, the second operator assisting with the unloading operation can prevent a mine from being left in the dunnage box if he sees the first operator placing it in the box, or if he sees the mine in the box while loading it. A human error probability of 0.01 was assigned to the second operator. Therefore, the overall failure probability per drum was calculated as follows:

$$10^{-2} \times 10^{-2} \times 0.1 \times 10^{-2} = 10^{-7}/\text{drum}$$

The frequency of inadvertently feeding a mine to the DUN is the product of the failure probability per drum multiplied by the number of mine drums processed per year.

Rockets, Mortars, and 105s

Inadvertently feeding a rocket, mortar, or 105 to the DUN requires that the following two faults occur:

1. The operators mistakenly leave a munition in the dunnage box.
2. The operator responsible for inspecting the dunnage box prior to charging it to the DUN fails to detect the munition.

From the analysis for the mines, the probability that the operators mistakenly leave a munition in the dunnage box is 10^{-5}. Since rockets, mortars, and 105s are sent to the UPA without all of the packing used for mines, the operator responsible for inspecting the dunnage box has

an excellent chance of detecting a munition mistakenly left in the dunnage box. Assigning an error probability of 0.01 to this inspection results in an overall failure probability per pallet of:

$$10^{-5} \times 10^{-2} = 10^{-7}/\text{pallet}$$

The frequency of inadvertently feeding a rocket, mortar, or 105 to the DUN is the product of the failure probability per pallet multiplied by the number of pallets processed per year.

Other Munitions

Mines, mortars, 105 mm projectiles, and rockets weigh 23, 25, 32, and approximately 56 lb, respectively. Because of their weight, these munitions can be handled by a single operator. All other munitions weigh in excess of 100 lb, except 155 mm projectiles which have a 95-lb minimum weight. Because of their weight, these munitions cannot be easily handled by a single operator. Although these other munitions can be fed to the DUN, the likelihood of this occurring is dominated by the probability that at least one operator commits an act of sabotage. The probability of this event cannot be quoted in an unclassified document.

7.1.6. Accident Analysis Summary and Results

Table 7-6 lists the internally-initated plant accident sequences which survived the preliminary screening. A complete list of all the accident sequences identified is provided in Appendix A.

Table 7-7 presents the accident frequency results for these sequences. The values shown are median values. The range factor column represents the rates of the 95th percentile value to the median value. More details on the uncertainty analysis are discussed in Secetion 7.3.

TABLE 7-6
INTERNAL EVENTS ACCIDENT SEQUENCES

Scenario ID	Description
P041	Failure to stop agent feed to the LIC, overloads the ventilation system.
P042	MPF explosion due to failure to stop fuel flow after a shutdown.
P043	MPF explosion due to hydraulic rupture of an unpunched bulk item. MPF room and ventilation integrity maintained.
P044	MPF explosion due to hydraulic rupture of an unpunched bulk item. MPF room or ventilation integrity lost.
P045	Ton container is spilled in the ECV, MDB structure fails due to subsequent agent fire.
P046	Munition detonation in the ECV, no fire.
P047	Munition detonation in the ECV, fire results but does not propagate.
P048	Munition detonation in ECV, fire results and propagates.
P049	Munition detonation in ECR causes structural and ventilation system failure.
P050	Munition detonation in ECR causes structural failure, a fire, and ventilation failure.
P051	Ton container spile in the MPB results in fire and structural failure.
P052	A burstered munition is fed to the DUN.

TABLE 7-7
PLANT OPERATIONS INTERNALLY-INITIATED ACCIDENT SEQUENCE FREQUENCIES (EVENTS/YEAR)

DATE21-Aug-87 PAGE1 PLTOPSOS

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
POAGC	41	3.3E-10	4.8E+01	N/A	--	3.3E-10	3.3E-10	N/A	--	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01
POAHC	41	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01
POAVC	41	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01
POBGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
PODHC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--
POCGC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--
POCHC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--
POKGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--
POKHC	42	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
POKVC	42	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--
POMVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
POPGC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
POPHC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--
POPVC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
POQGC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
POQVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
PORGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
PORVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
POSVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01
POBGC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-09	4.1E+01	1.6E-09	4.1E+01
POKGC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-10	4.1E+01	N/A	--
POKHC	43	2.7E-10	4.1E+01	2.7E-10	4.1E+01	N/A	--	N/A	--	2.7E-10	4.1E+01	N/A	--	2.7E-10	4.1E+01	2.7E-10	4.1E+01
POKVC	43	N/A	--	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--
POSVC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.8E-10	4.1E+01	1.8E-10	4.1E+01
POBGC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	4.1E+01	1.6E-10	4.1E+01
POKGC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-10	4.1E+01	N/A	--
POKHC	44	2.7E-10	4.1E+01	2.7E-10	4.1E+01	N/A	--	N/A	--	2.7E-10	4.1E+01	N/A	--	2.7E-10	4.1E+01	2.7E-10	4.1E+01
POKVC	44	N/A	--	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--

TABLE 7-7 (Continued)

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOSVC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.8E-10	4.1E+01	1.8E-10	4.1E+01
FOKGF	45	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--
FOKHF	45	4.0E-10	1.4E+01	4.0E-10	1.4E+01	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--	4.0E-10	1.4E+01	4.0E-10	1.4E+01
FOKVF	45	N/A	--	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--
PODHC	46	9.0E-09	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-09	2.6E+01	9.0E-09	2.6E+01	N/A	--
POCGC	46	1.0E-08	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	2.6E+01	N/A	--
POCHC	46	1.0E-08	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	2.6E+01	N/A	--	N/A	--
FOMVC	46	4.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	4.0E-07	2.6E+01	N/A	--	4.0E-07	2.6E+01	4.0E-07	2.6E+01
FOPGC	46	6.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01
FOPHC	46	6.0E-07	2.6E+01	N/A	--	6.0E-07	2.6E+01	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01	N/A	--
FOPVC	46	6.0E-07	2.6E+01	N/A	--	6.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01
POQGC	46	3.0E-07	2.6E+01	N/A	--	3.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	3.0E-07	2.6E+01	3.0E-07	2.6E+01
POQVC	46	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-07	2.6E+01	3.0E-07	2.6E+01
PORGC	46	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01
PORVC	46	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01
PODHC	47	8.1E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	8.1E-11	3.1E+01	8.1E-11	3.1E+01	N/A	--
POCGC	47	9.0E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-11	3.1E+01	N/A	--
POCHC	47	9.0E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-11	3.1E+01	N/A	--	N/A	--
FOMVC	47	3.6E-09	3.1E+01	N/A	--	N/A	--	N/A	--	3.6E-09	3.1E+01	N/A	--	3.6E-09	3.1E+01	3.6E-09	3.1E+01
POPGC	47	5.4E-09	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01
POPHC	47	5.4E-09	3.1E+01	N/A	--	5.4E-09	3.1E+01	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01	N/A	--
POPVC	47	5.4E-09	3.1E+01	N/A	--	5.4E-09	3.1E+01	N/A	--	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01
POQGC	47	2.7E-09	3.1E+01	N/A	--	2.7E-09	3.1E+01	N/A	--	N/A	--	N/A	--	2.7E-09	3.1E+01	2.7E-09	3.1E+01
FOQVC	47	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-09	3.1E+01	2.7E-09	3.1E+01
PORGC	47	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01
PORVC	47	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01
PODHC	48	9.0E-12	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-12	3.3E+01	9.0E-12	3.3E+01	N/A	--
POCGC	48	1.0E-11	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-11	3.3E+01	N/A	--

TABLE 7-7 (Continued)

FLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
POCHC	48	1.0E-11	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-11	3.3E+01	N/A	--	N/A	--
POMVC	48	4.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	4.0E-10	3.3E+01	N/A	--	4.0E-10	3.3E+01	4.0E-10	3.3E+01
POFGC	48	6.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01
POFHC	48	6.0E-10	3.3E+01	N/A	--	6.0E-10	3.3E+01	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01	N/A	--
POPVC	48	6.0E-10	3.3E+01	N/A	--	6.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01
POQGC	48	3.0E-10	3.3E+01	N/A	--	3.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	3.0E-10	3.3E+01	3.0E-10	3.3E+01
POQVC	48	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-10	3.3E+01	3.0E-10	3.3E+01
PORGC	48	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	1.5E-09	3.2E+01
PORVC	48	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	1.5E-09	3.2E+01
FODHC	49	3.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-06	3.1E+01	3.0E-06	3.1E+01	N/A	--
POCGC	49	4.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-06	3.1E+01	N/A	--
POCHC	49	4.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-06	3.1E+01	N/A	--	N/A	--
POMVC	49	4.0E-09	3.7E+01	N/A	--	N/A	--	N/A	--	4.0E-09	3.7E+01	N/A	--	4.0E-09	3.7E+01	4.0E-09	3.7E+01
FOPGC	49	2.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01
POFHC	49	2.0E-06	3.1E+01	N/A	--	2.0E-06	3.1E+01	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01	N/A	--
POFVC	49	2.0E-06	3.1E+01	N/A	--	2.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01
POQGC	49	8.0E-07	3.1E+01	N/A	--	8.0E-07	3.1E+01	N/A	--	N/A	--	N/A	--	8.0E-07	3.1E+01	8.0E-07	3.1E+01
FOQVC	49	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-07	3.1E+01	8.0E-07	3.1E+01
FORGC	49	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01
FORVC	49	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01
FODHC	50	3.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-08	3.7E+01	3.0E-08	3.7E+01	N/A	--
FOCGC	50	4.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-08	3.7E+01	N/A	--
POCHC	50	4.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-08	3.7E+01	N/A	--	N/A	--
POMVC	50	4.0E-11	3.7E+01	N/A	--	N/A	--	N/A	--	4.0E-11	3.7E+01	N/A	--	4.0E-11	3.7E+01	4.0E-11	3.7E+01
FOFGC	50	2.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01
POFHC	50	2.0E-08	3.7E+01	N/A	--	2.0E-08	3.7E+01	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01	N/A	--
FOPVC	50	2.0E-08	3.7E+01	N/A	--	2.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01
FOQGC	50	8.0E-09	3.7E+01	N/A	--	8.0E-09	3.7E+01	N/A	--	N/A	--	N/A	--	8.0E-09	3.7E+01	8.0E-09	3.7E+01

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TABLE 7-7 (Continued)

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
POQVC	50	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-09	3.7E+01	8.0E-09	3.7E+01
PORGC	50	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01
PORVC	50	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01
POKGF	51	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--
POKHF	51	4.0E-09	1.4E+01	4.0E-09	1.4E+01	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	4.0E-09	1.4E+01	4.0E-09	1.4E+01
POKVF	51	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--
PODHC	52	4.4E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-03	5.7E+01	4.4E-03	5.7E+01	N/A	--
POCGC	52	5.0E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-03	5.7E+01	N/A	--
POCHC	52	5.0E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-03	5.7E+01	N/A	--	N/A	--
POMVC	52	1.1E-02	5.7E+01	N/A	--	N/A	--	N/A	--	1.1E-02	5.7E+01	N/A	--	1.1E-02	5.7E+01	1.1E-02	5.7E+01
POPGC	52	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
POPHC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--
POPVC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
POQGC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
POQVC	52	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
PORGC	52	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	1.6E-03	5.7E+01
PORVC	52	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	1.6E-03	5.7E+01

7.2. EXTERNAL EVENTS

The following external event initiators were considered in the development of plant-related accident scenarios which could lead to the release of a significant amount of chemical agent:

1. Tornadoes and high winds.
2. Meteorite strikes.
3. Aircraft crashes.
4. Earthquakes.
5. Lightning.

For this study, the demil facility is defined to include (1) the MHI where munitions awaiting demilitarization are temporarily stored and (2) the MDB which houses the systems and equipments to destroy the explosives and agent contained in the various munitions. The accident sequences identified were subjected to a preliminary screening process by assigning very conservative failure probability values. The screening criteria for frequency and agent release are described in Section 4.

The initiating event families for plan operations were identified in Section 4.1. Table 7-8 lists the accident sequences related to plant operations initiated by external events. The event tree models are presented in Figs. 7-39 through 7-44.

7.2.1. Tornadoes and High Winds

The accident scenarios identified involve the breaching of the munitions in the MHI and the UPA by tornado- or high wind-generated missiles. This failure mode was determined to be more credible than a tornado/high wind-induced building collapse which could lead to the crushing of munitions by the falling structure. For UBC designed structures such as the MDB, the wind loads will fail the walls of the

TABLE 7-8
MASTER LIST OF EXTERNALLY-INITIATED PLANT ACCIDENT SCENARIOS

Scenario ID	Description
P01	Tornado-generated missile puncture/crush munitions in the MHI.
P02	Tornado-generated missile detonate munitions in the MHI.
P03	Tornado-generated missile puncture/crush munitions in the UPA.
P04	Tornado-generated missile detonate munitions in the UPA.
P05	Tornado-generated missile damages the agent piping system between the BDS and TOX at TEAD (bulk-only facility).
P06	Meteorite strikes the MHI.
P07	Meteorite strikes the UPA.
P07A	Meteorite strikes the TOX.
P08	Meteorite strikes the agent piping system between the BDS and TOX at TEAD (bulk-only facility).
P09	Direct large aircraft crash onto the MHI; no fire.
P010	Direct large aircraft crash onto the MHI; fire not contained in 0.5 h.
P011	Direct large aircraft crash onto the MHI; fire contained in 0.5 h.
P012	Direct large aircraft crash damages the MDB; no fire.
P013	Direct large aircraft crash damages the MDB; fire not contained in 0.5 h.
P014	Direct large aircraft crash damages the MDB; fire contained in 0.5 h.
P015	Indirect large aircraft crash damages the MHI; no fire.
P016	Indirect large aircraft crash damages the MHI; fire not contained in 0.5 h.
P017	Indirect large aircraft crash damages the MHI; fire contained in 0.5 h.

TABLE 7-8 (Continued)

Scenario ID	Description
P018	Indirect large aircraft crash damages the MDB; no fire.
P019	Indirect large aircraft crash damages the MDB; fire not contained in 0.5 h.
P020	Indirect large aircraft crash damages the MDB; fire contained in 0.5 h.
P021	Direct crash of a large or small aircraft damages the outdoor agent piping system at TEAD; no fire.
P022	Direct crash of a large or small aircraft damages the outdoor agent piping system at TEAD; fire occurs and not contained.
P023	Earthquake causes the munitions in the MHI to fall and be punctured.[a]
P024	Earthquake causes munitions in the MHI to fall and detonate.[a]
P025	Earthquake damages the MDB structure, munitions fall and are punctured; fire suppressed.
P026	Earthquake damages the MDB structure, munitions fall and are punctured; earthquake also initiates fire; fire suppression system fails.
P028A[b]	Earthquake damages the MDB structure, munitions fall and are punctured; TOX damaged; fire occurs; fire suppressed.
P028	Earthquake damages the MDB structure, munitions fall and are punctured; TOX damaged; fire occurs; fire suppression system fails.
P029	Earthquake damages the MDB; munitions are intact; fire occurs; fire suppression system fails.
P030	Earthquake damages the MDB; munitions are intact; TOX damaged; no fire occurs.[c]
P031A	Earthquake damages the MDB; munitions are intact; TOX damaged; fire occurs; fire suppressed.
P031	Earthquake damages the MDB; munitions are intact; TOX damaged; fire occurs; fire not suppressed.

TABLE 7-8 (Continued)

Scenario ID	Description
P032	Earthquake causes munitions to fall and detonate; MDB breached by detonation; the TOX is intact; no fire.[c]
P033	Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is intact; earthquake also initiates fire; fire suppression system fails.
P034	Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is damaged; fire occurs; fire suppression system fails.

[a] Screened out due to design changes.
[b] Sequence 27 not used.
[c] Screened out on the basis of frequency.

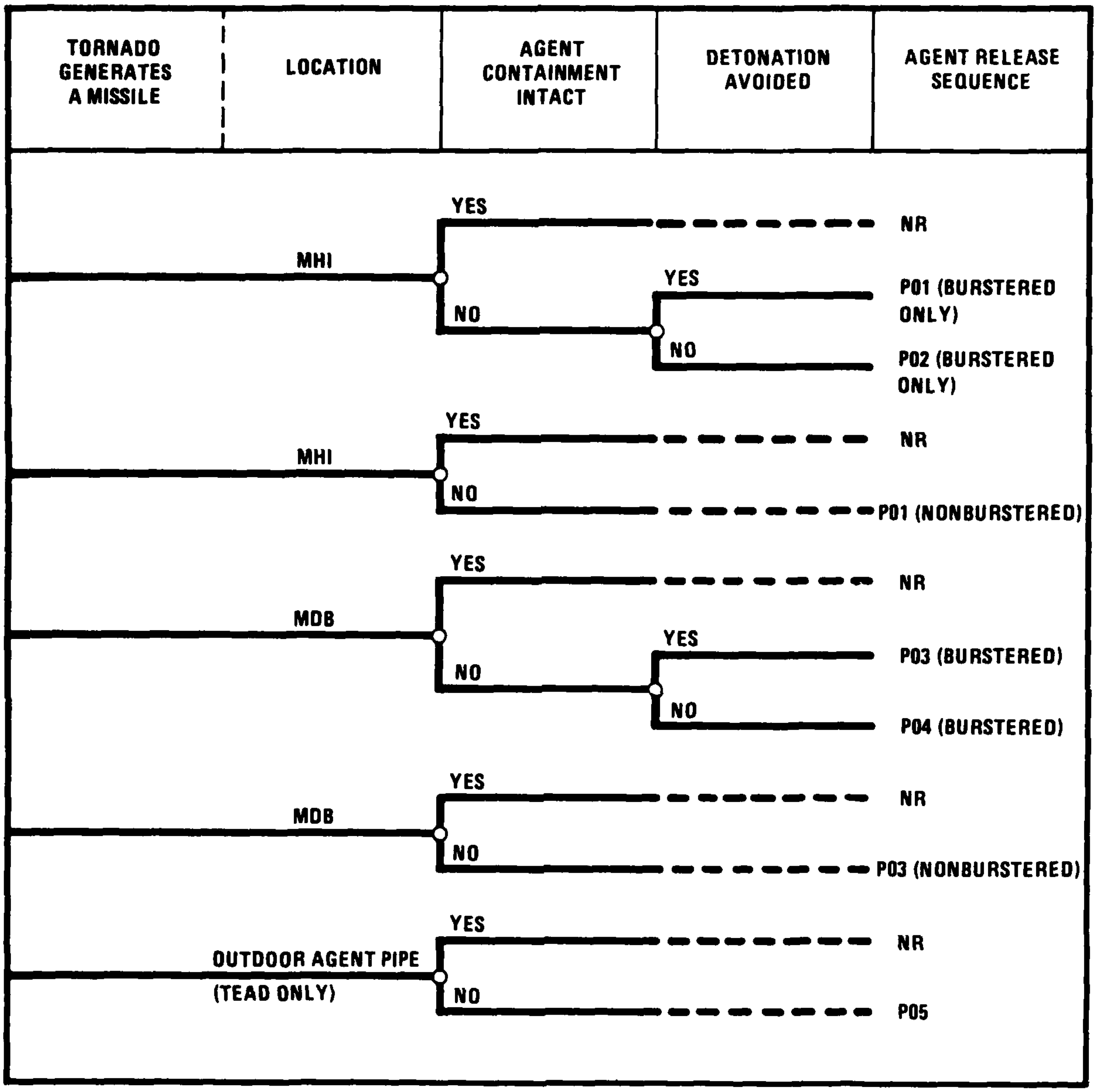

Fig. 7-39. Tornado-induced agent release scenarios

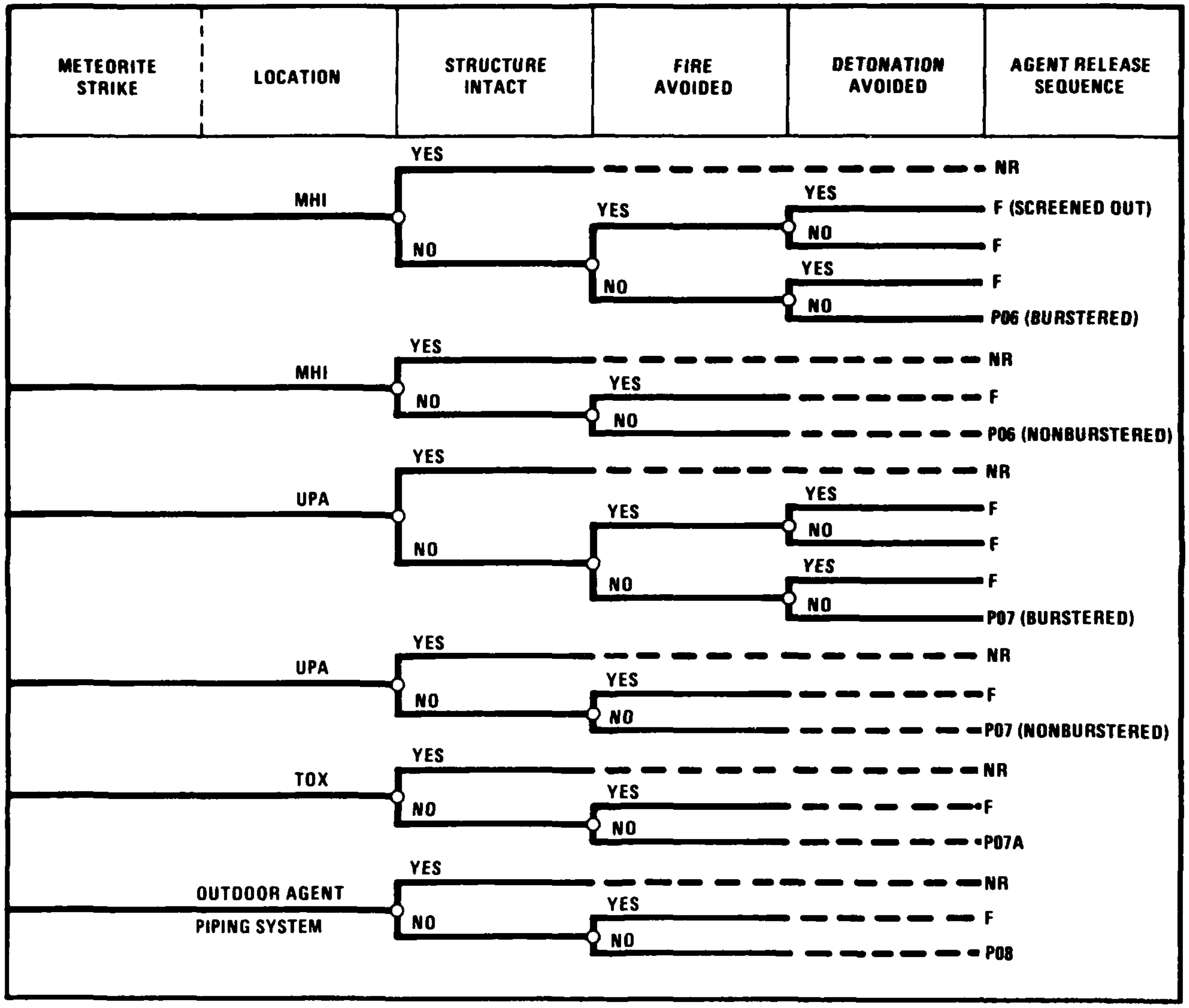

Fig. 7-40. Meteorite-induced agent release scenarios

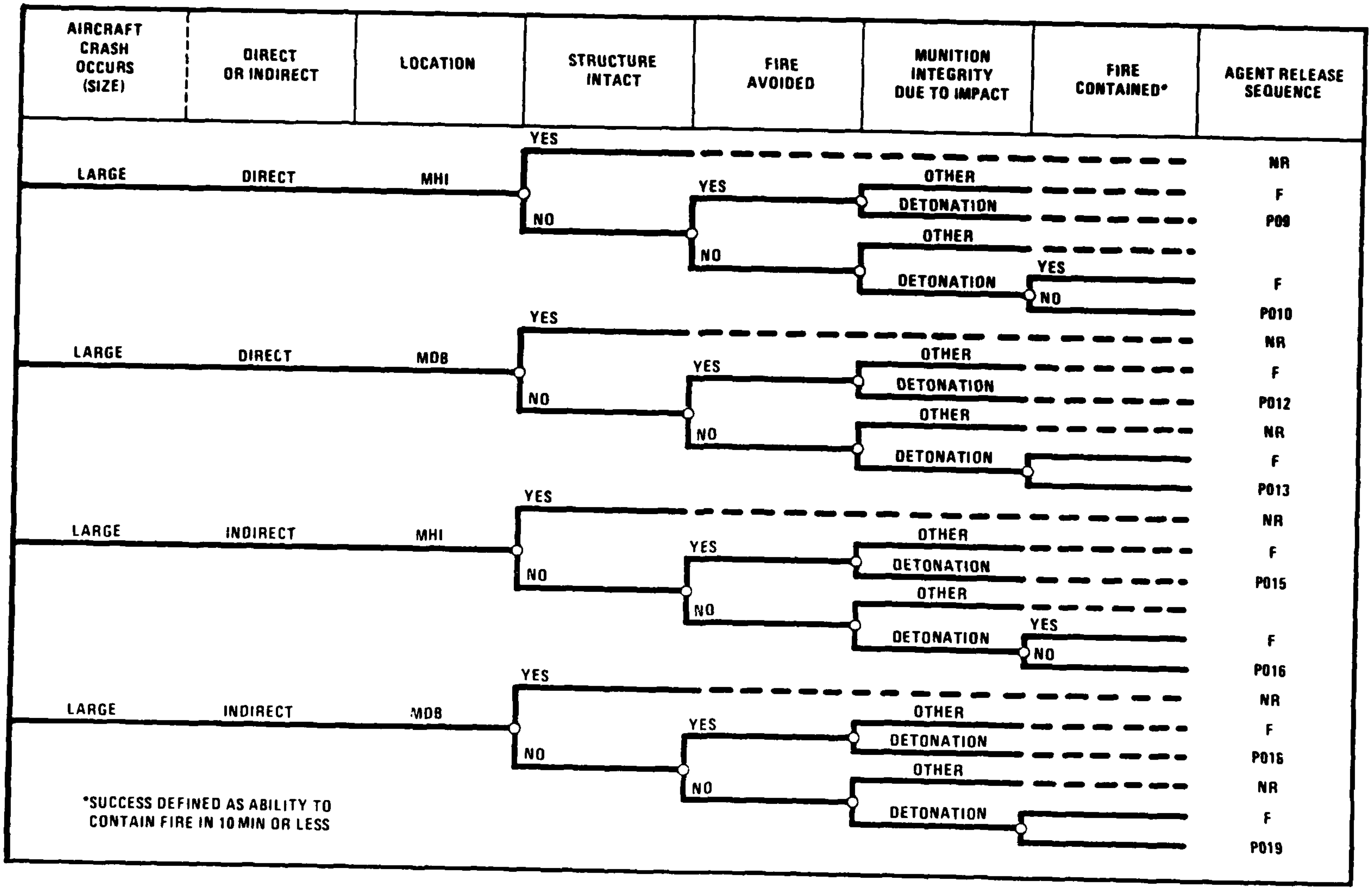

Fig. 7-41. Large aircraft crash onto MHI/MDB containing burstered munitions

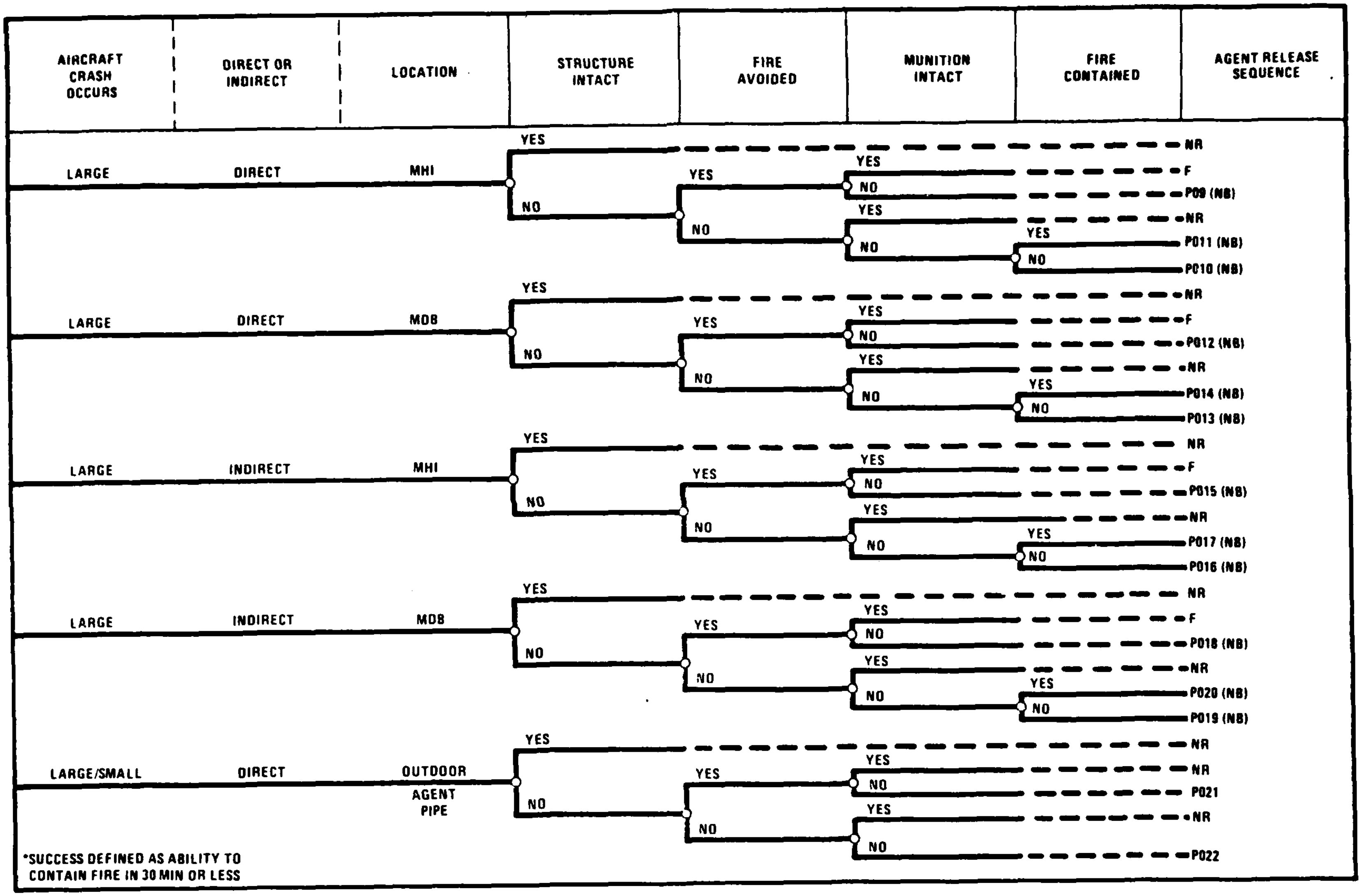

Fig. 7-42. Aircraft crash onto MHI/MDB with nonburstered (NB) munitions

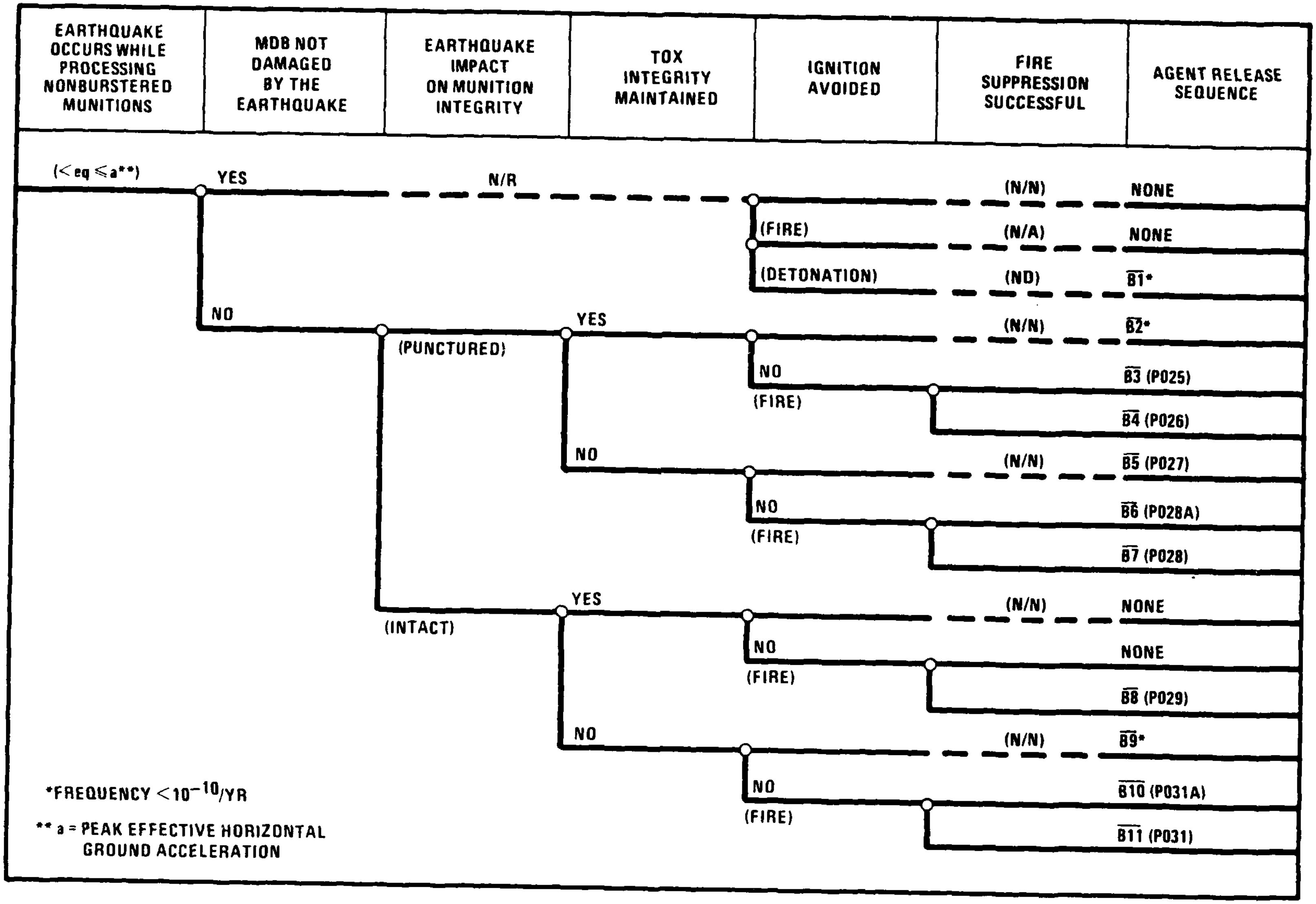

Fig. 7-43. Event tree: earthquake-induced releases from the MDB involving bulk containers

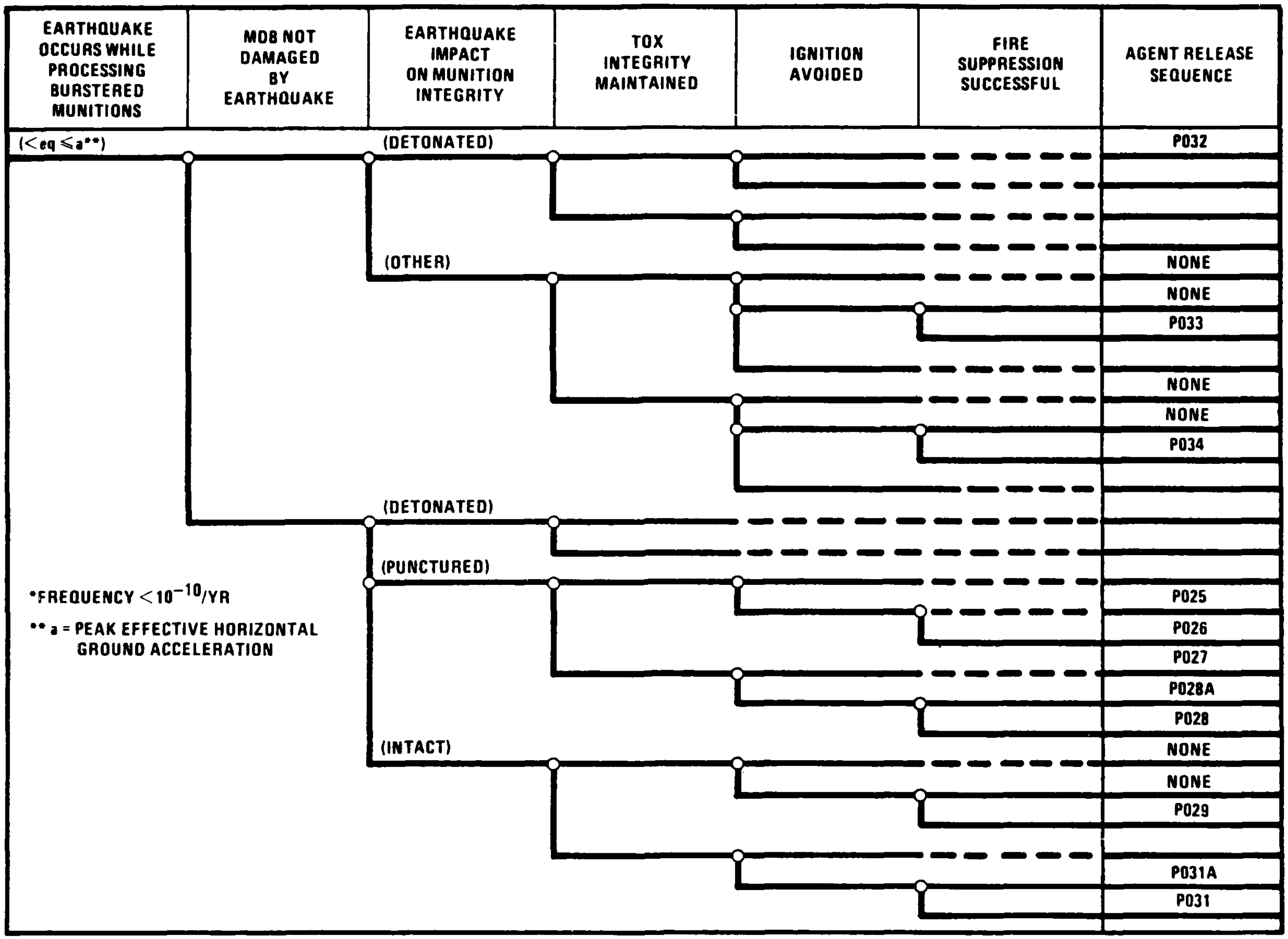

Fig. 7-44. Event tree: earthquake-induced releases from the MDB involving burstered munitions

structure before the structure will collapse. Storage igloos like the MHI have been designed to resist the direct effects of tornadoes with winds up to 320 mph except for the possibility of missiles breaching the igloo doors (Ref. 7-4). In the MDB, only the UPA has been determined to be vulnerable to tornado/high wind-generated missiles that could result in significant agent releases.

An additional scenario that applies to the modified CAMDS facility at TEAD has been identified. This involves the susceptibility of the outdoor agent piping system that links the bulk drain station and the TOX which will be located in a separate building.

The event tree developed to define relevant accident sequences is shown in Fig. 7-39. No sequences could be screened out initially as more detailed quantitative analysis is required to determine the necessary wind velocity to generate missiles which could penetrate the munitions. Hence, all the accident sequences numbered in the event tree were quantified. They are:

P01 - Tornado-generated missiles puncture/crush the munitions in the MHI.

P02 - Tornado-generated missiles detonate the burstered munitions in the MHI.

P03 - Tornado-generated missiles breach the munitions in the UPA.

P04 - Tornado-generated missiles detonate the burstered munitions in the UPA.

P05 - Tornado-generated missiles breach the agent piping system between the BDS and TOX at TEAD (CAMDS-modified bulk only facility).

7.2.1.1. <u>Tornado and High Wind Accident Analysis</u>. Essentially, the missile penetration of the munition inside the MHI or UPA occurs if (1) a tornado or extremely high wind occurs with a velocity sufficient to generate a missile that could penetrate the MHI door or UPA wall and a munition, and (2) the missile actually hits the target munition. The probability of a missile hitting and rupturing a munition is the product of four variables: (1) the probability that the velocity vector of the missile is nearly perpendicular to the target; (2) the probability that the missile is oriented properly to penetrate the target; (3) the number of missiles per square foot of wind; and (4) the target area. More details on the derivation of these variables are provided in the calculation sheets (Ref. 7-5). If the missile hits a burstered munition, two failure modes are possible, (1) the munition is opened up due to puncture or crush, or (2) the missile impact causes munition detonation due to the application of a force greater than the "undue force."

<u>Scenario P01 - Tornado-Generated Missile Penetrates Munitions in the MHI (No Detonations Occur)</u>

The MHI is assumed to be an 80-ft long by 27-ft wide igloo with a concrete door for all sites. The munitions are stored in onsite transportation containers, except the spray tanks and wet eye bombs which are in their existing overpacks and not in onsite transportation containers. There will be a maximum of 16 containers in the MHI.

For an agent release to occur, the missile must penetrate the igloo door, the onsite container, and the munition itself. The required initial velocity (V) to puncture the munition is given by:

$$V = V_D^2 + V_C^2 + V_m^2 \quad , \qquad (7\text{-}1)$$

where V_D = door penetration velocity,

V_C = onsite container penetration velocity,

V_m = munition penetration velocity (munition specific).

The puncture velocity for a concrete igloo door has been analyzed previously (Ref. 7-5) and was calculated to be 54 mph assuming the missile is a utility pole. The puncture velocity for the onsite container was calculated to be 63 mph. The penetration velocity for the munition itself is munition specific and is largely a function of the thickness of the munition. Details are provided in the calculation sheets. Having calculated the required initial missile velocity, the required wind velocity to generate the missile is determined in Section 4.2. The frequency of occurrence of a given wind speed is determined from the set of curves given in Section 4.

Scenario P02 - Tornado-Generated Missile Penetrate Munitions in the MHI; Detonation Results from Impact

The analysis of scenarios P02 included the estimation of the probability that a missile impacting a munition would cause it to detonate. The data presented in Ref. 7-6 indicated that a projectile with Comp B explosive could ignite when subjected to a minimum impact velocity of 123 mph. Because the conditions of the tests described in Ref. 7-6 do not fully apply to the conditions being considered here (i.e., the shell casing provides protection for the bursters), it is assumed that there is a 50% chance that a munition will detonate at 123 mph. Furthermore, we also estimate the probability of a detonation resulting from a drop of the munition from a height of 40 ft to be 10^{-3} (Ref. 7-9). The 40 ft drop height corresponds to a free fall velocity (in a vacuum) of about 34.6 mph. To determine the probability of detonating a munition at an impact velocity equivalent to that of a missile required to penetrate the igloo and the munition, we assumed a lognormal distribution and derived the necessary parameters (e.g., standard deviation and standard normal deviate) from these two data points. The results are shown in the data base table (Table 7-9). The calculation details are given in the calculation sheets (Ref. 7-5).

TABLE 7-9
DATA BASE FOR TORNADO-INITIATED EVENTS FOR PLANT OPERATIONS

[illegible] Page 1

Data Base For Tornado-Initiated Events For Plant Operations

Event	Site	Munition Type	Variable Name	MHI	Variable Name	MOB	Variable Name	Open Area	Error Factor	Reference
1. Frequency wind sufficient to generate missile	ANAD	105-mm cartrg	ANMHIC	8.9E-07	ANMOBC	1.5E-06			10	SEE CALC SHEETS
		4.2-in mortar	ANMHID	1.1E-06	ANMOBD	1.5E-06			10	
		ton contnr	ANMHIK	1.4E-07	ANMOBK	7.3E-07			10	
		mine	ANMHIM	1.1E-06	ANMOBM	1.5E-06			10	
		155-mm proj	ANMHIP	7.4E-07	ANMOBP	1.5E-06			10	
		8-in proj	ANMHIQ	7.4E-07	ANMOBQ	1.5E-06			10	
		rockets	ANMHIR	1.1E-06	ANMOBR	1.5E-06			10	
	APG	ton contnr			APMOBK	4.5E-08				
	LBAD	155-mm proj	LBMHIP	1.3E-06	LBMOBP	1.5E-06			10	
		8-in proj	LBMHIQ	1.5E-06	LBMOBQ	1.5E-06			10	
		rocket	LBMHIR	1.5E-06	LBMOBR	1.5E-06			10	
	NAAP	ton contnr			NAMOBK	7.3E-07			10	
	PBA	ton contnr	PBMHIK	3.8E-07	PBMOBK	7.3E-07				
		mine	PBMHIM	1.5E-06	PBMOBM	1.5E-06			10	
		rocket	PBMHIR	1.5E-06	PBMOBR	1.5E-06			10	
	PUDA	105-mm cartrg	PUMHIC	1.0E-07	PUMOBC	1.0E-07			10	
		4.2-in mortar	PUMHID	1.0E-07	PUMOBD	1.0E-07			10	
		155-mm proj	PUMHIP	1.0E-07	PUMOBP	1.0E-07			10	
	TEAD	bomb	TEMHIB	3.6E-10	TEMOBB	8.1E-10			10	
		105-mm cartrg	TEMHIC	1.8E-09	TEMOBC	1.8E-09			10	
		4.2-in mortar	TEMHID	1.8E-09	TEMOBD	1.8E-09			10	
		ton contnr	TEMHIK	2.4E-10	TEMOBK	7.3E-10			10	
		mine	TEMHIM	1.8E-09	TEMOBM	1.8E-09			10	
		155-mm proj	TEMHIP	1.5E-09	TEMOBP	1.8E-09			10	
		8-in proj	TEMHIQ	1.8E-09	TEMOBQ	1.8E-09			10	
		rocket	TEMHIR	1.8E-09	TEMOBR	1.8E-09			10	
		spray tank	TEMHIS	1.1E-09	TEMOBS	1.8E-09			10	
	UMDA	bomb	UMMHIB	3.6E-10	UMMOBB	8.1E-10			10	
		ton contnr	UMMHIK	2.4E-10	UMMOBK	7.3E-10			10	
		mine	UMMHIM	1.8E-09	UMMOBM	1.8E-09			10	
		155-mm proj	UMMHIP	1.5E-09	UMMOBP	1.8E-09			10	
		8-in proj	UMMHIQ	1.8E-09	UMMOBQ	1.8E-09			10	
		rocket	UMMHIR	1.8E-09	UMMOBR	1.8E-09			10	
		spray tank	UMMHIS	1.1E-09	UMMOBS	1.8E-09			10	
	TEAD	B,K,S(PIPE)					CDOPA	1.8E-09	10	

TABLE 7-9 (Continued)

2. Probability munition penetrated	All	bomb	MHIPTB	4.3E-07	MDBPTB	2.6E-06			50
		105-mm cartrg	MHIPTC	2.4E-07	MDBPTC	1.5E-06			50
		4.2-in mortar	MHIPTD	7.3E-07	MDBPTD	4.4E-06			50
		ton contnr	MHIPTK	8.2E-07	MDBPTK	4.9E-06			50
		mine	MHIPTM	8.6E-07	MDBPTM	5.1E-06			50
		155-mm proj	MHIPTP	3.8E-07	MDBPTP	2.3E-06			50
		8-in proj	MHIPTQ	3.8E-07	MDBPTQ	2.3E-06			50
		rocket	MHIPTR	7.8E-07	MDBPTR	4.7E-06			50
		spray tank	MHIPTS	3.4E-07	MDBPTS	8.4E-06			50
	All	All	IGLPT	3.2E-06					50
3. Prob. pipe penetrated	TEAD	B,K,S(PIPE)					CDPTP	1.3E-02	50
4. Munition detonates	All	All	DEMHI	1.7E-01	DEMDB	7.0E-02			2

Sequence P03 - Tornado-Generated Missile Penetrate Munitions in the UPA

Except for accounting for the difference in the structure of the UPA, the same analytical approach described in scenario P01 was used. The UPA is located on the second floor of the MDB and will contain as many as six onsite containers at any given time. The wall of the MDB is constructed of two layers of thin steel sheets (thickness is approximately 0.047 in.), separated by an insulation material for a total thickness of approximately 2 in. Details of the analysis are given in the calculation sheets (Ref. 7-5).

Sequence P04 - Tornado-Generated Missile Penetrate Munitions in the UPA; Burstered Munitions Detonate Upon Impact

The analysis of sequence P04 follows the same approach as sequence P02. The probability of munition detonation is calculated from the missile impact velocity upon penetration. Details are given in the calculation sheets (Ref. 7-5).

Sequence P05 - Tornado-Generated Missile Breach the Outdoor Age. Piping System at the Modified CAMDS Bulk-Only Facility

Analysis of sequence P05 also followed the same approach described above except that only a double-walled pipe had to be breached in order to result in an agent release.

7.2.2. Meteorite Strikes

Like tornado-generated missiles, meteorites striking the MHI, MDB, and the outdoor agent piping system at TEAD can lead to a significant amount of agent release. The consequence of such an accident is more severe than that from a tornado-generated missile because meteorite strikes generally involve fires. Hence, if burstered munitions are

involved, explosive detonations could occur from the fire or from direct impact, leading to instantaneous agent releases.

The event tree developed for meteorite-initiated accidents is shown in Fig. 7-30. The sequences could not be subjected to any preliminary screening without doing a more detailed analysis of the what type (stone or iron) and size of meteorite is capable of penetrating munitions in the MHI or damaging the MDB which contain not only intact munitions (primarily in the UPA) but a large agent holding tank (in the TOX).

The accident sequences identified are:

P06 - Meteorite strikes the MHI and if burstered munitions are involved, detonations are assumed to occur.

P07 - Meteorite strikes the UPA and if burstered munitions are involved, detonations are assumed to occur.

P07A - Meteorite strikes the TOX.

P08 - Meteorite strikes the outdoor agent piping system at TEAD (CAMDS-modified bulk only facility).

7.2.2.1. Meteorite Strike Accident Analysis. The frequency of meteorite strikes for meteorites weighing 1.0 lb or greater is $(6.4 \times 10^{-13})/ft^2$ (Ref. 7-7). For small meteorites (one ton or less), stone meteorites are approximately ten time more common than iron. However, iron meteorites are more dense and tend to have higher impact velocities and therefore represent a significant portion of the total meteorites that can rupture the munitions. The meteorite size distribution data has been presented in Section 4.2.

Sequence P06 - Meteorite Strikes the MHI

The munitions in the MHI are stored in their onsite transportation containers. For agent to be released given a meteorite strike, the meteorite has to penetrate 2 ft of soil and 6 in. of concrete roof, the onsite container, and the munition wall. Hence, there are essentially four layers of structural barrier. The minimum meteorite impact velocity that would collapse the 6-in. thick concrete roof is 1500 fps for a stone meteorite and 3800 fps for an iron meteorite. The overall frequency of a meteorite capable of penetrating and rupturing the munitions in the MHI is:

$$F_t = F(f_s + f_i)\ A \times S \quad , \tag{7-2}$$

where F = the frequency of a meteorite weighing one pound or more striking the earth, $6.4 \times 10^{-13}/ft^2$,

f_s = fraction of stone meteorites which can penetrate the target,

f_i = fraction of iron meteorites which can penetrate the target,

A = target area (80 x 12 ft),

S = spacing factor.

It is assumed that burstered munitions will detonate when struck by a meteorite. Fire is also expected to occur. Details of the calculations are given in Ref. 7-5.

Sequence P07 - Meteorite Strikes the UPA

In this sequence the meteorite has to penetrate the 6-in. thick concrete roof of the MDB, the onsite container, and the munition itself. The same approach described in P06 is used here. Quantification details are provided in Ref. 7-5.

Sequence P07A - Meteorite Strikes the TOX

The TOX is located in the first floor of the MDB. The ceiling of the TOX is a minimum 12-in. thick. This is the most likely area vulnerable to a meteorite strike. Detailed calculations presented in Ref. 7-5 indicate that either a 200-lb stone meteorite or 20-lb iron meteorite can penetrate the TOX ceiling.

7.2.3. Aircraft Crashes

The aircraft crash-initiated accidents affecting the MHI and the MDB are similar to those affecting the storage igloos and warehouses. Both direct and indirect (i.e., adjacent to the building) crashes were considered. The aircraft crash may or not result in a fire. Furthermore, the ability to contain the fire in the shortest time possible influences the severity of the accident.

The event trees developed are shown in Figs. 7-41 and 7-42. No preliminary screening could be performed until the actual aircraft crash frequencies at each site had been analyzed. However, once the accident frequencies were quantified, those which have freqencies of 10^{-10}/yr or less were not analyzed for the agent release quantities. The accident sequences that have been defined from the event trees are as follows:

P09 - Direct large aircraft crash onto the MHI; no fire.

P010 - Direct large aircraft crash onto the MHI; fire not contained in 0.5 h.

P011 - Direct large aircraft crash onto the MHI; fire contained in 0.5 h.

P012 - Direct large aircraft crash damages the MDB; no fire.*

P013 - Direct large aircraft crash damages the MDB; fire not contained in 0.5 h.*

P014 - Direct large aircraft crash damages the MDB; fire contained in 0.5 h.*

P015 - Indirect large aircraft crash damages the MHI; no fire.

P016 - Indirect large aircraft crash damages the MHI; fire not contained in 0.5 h.

P017 - Indirect large aircraft crash damages the MHI; fire contained in 0.5 h.

P018 - Indirect large aircraft crash damages the MDB; no fire.*

P019 - Indirect large aircraft crash damages the MDB; fire not contained in 0.5 h.*

P020 - Indirect large aircraft crash damages the MDB; fire contained in 0.5 h.*

P021 - Large and small aircraft direct crash damages the outdoor agent piping system at TEAD; no fire.

P022 - Large and small aircraft direct crash damages the outdoor agent piping system at TEAD; fire occurs and not contained.

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*Does not include effects of crash on outdoor piping sytem of the modified CAMDS facility at TEAD, which is considered separately.

7.2.3.1. Aircraft Crash Accident Analysis. In summary, the following general assumptions were made in deriving the large/small aircraft accident sequences:

1. For a large aircraft crash onto burstered munitions, it is assumed that detonations will occur for direct hits; only rockets and mines detonate from indirect hits; and, if a fire occurs, it is uncontained.

2. No small aircraft crashes were assumed to be able to sufficiently damage the MHI or the MDB to cause agent releases.

3. The vulnerability of the outdoor agent piping system at the modified CAMDS bulk facility (TEAD) was analyzed separately.

Direct Large Aircraft Crash Onto the MHI/MDB; No Fire (P09, P012)

Only large aircraft crashes have been found to significantly damage the MDB or the MHI. For a direct aircraft crash, the target area is the surface area of the building. Even if the crash does not lead to a fire, the impact of the crash is strong enough to cause the detonation of burstered munitions. The transportation data presented in Ref. 7-8 indicate that 55% of all air crashes do not involve fires. Quantification details are provided in Ref. 7-5.

Direct Large Aircraft Crash onto the MHI/MDB; Fire Not Contained in 0.5 h (P010, P013)

The analysis of these sequences follows the same approach as P09 and P012. The transportation data indicate that 45% of all aircraft crashes result in fires.

The successful containment of the fire is defined here to be 0.5 h for nonburstered munitions. This time was selected based on the

thermal failure threshold data presented in Appendix F, which indicate that direct heating of ton containers for 36 min leads to hydraulic rupture. For burstered munitions in onsite containers, the thermal failure threshold is conservatively defined as 15 min, which is the package design criteria for an all engulfing fire. Since the Army policy is not to fight a fire involving direct heating of burstered munitions, the probability of the "not containing the fire in 0.5 h" event is essentially unity.

The amount of agent released from bulk containers subjected to aircraft crash fires depends on the ability to contain the fire. If fire is allowed to progress for more than 30 min, more containers will rupture. The approach for quantifying the probability of successful containment of an aircraft crash fire has been discussed in Section 5.

Direct Large Aircraft Crash onto the MHI; Fire Contained in 0.5 h (P011, P014)

These scenarios essentially apply to nonburstered munitions only. If an airplane crashes directly onto the MHI or MDB containing non-burstered munitions, it is expected that every means available will be employed to terminate the fire immediately. The sooner the fire is extinguished the fewer munitions will be subjected to thermal rupture. Although the munitions are stored in onsite containers they are only provided 15-min protection from an all engulfing fire. The approach for calculating the probability of containing the fire in 0.5 h or less has been discussed in P010. The quantification details are provided in Ref. 7-5.

Indirect Large Aircraft Crash onto MHI/MDB; No Fire (P015, P018)

For an indirect crash, the target area is determined by increasing all building perimeters by 200 ft. To determine the probability that

the building will be damaged by flying debris from an aircraft crash in the vicinity of the building, the following assumptions were made:

1. The airplane can skid 100 ft and still damage the MHI.
2. The airplane can skid 150 ft and still damage the MDB.
3. 10% of all crashes are directed towards the igloo door.
4. 25% of all crashes are directed towards the MDB (i.e, either the TOX or the UPA may be hit).

For the MHI, the total probability of an aircraft part damaging the munition in containers is the sum of the probability that the missile will rupture the structure (including the munition at its line of sight) and the probability that the door is open at the time of the crash and the missile enters the open door and hits the munitions.

The probability that the missile will rupture the structure and the munitions is calculated as follows:

$$P_i = 0.10 \times A_i/A_{LA} \quad , \qquad (7\text{-}3)$$

where A_i = the area of the crash that could damage the igloo door if closed,

A_{LA} = the target area for an indirect large aircraft crash.

The SAI study (Ref. 7-4) indicates that the igloo door may be open 1% of the time. Since only 10% of all crashes are directed towards the door, the probability that the door is open and missile hits the munition through the open door is 0.001.

For the MDB, it is assumed that the either the TOX or the UPA may be the most vulnerable to a missile strike. Assuming that there was a

25% chance of the airplane crashing towards the TOX or the UPA, the probability of damaging the TOX or UPA is:

$$P_t = 0.25 \times A_t/A_{LA} \quad , \tag{7-4}$$

where A_t = the area of crash capable of damaging the TOX or UPA,
A_{LA} = the target area for an indirect crash of a large aircraft.

Quantification details are provided in Ref. 7-5.

Indirect Large Aircraft Crash Damages the MHI/MDB; Fire Not Contained in 0.5 h (P016, P019)

The same approach discussed above is applied to the analysis of these scenarios.

Indirect Large Aircraft Crash Damages the MHI/MDB; Fire Contained in 0.5 h (P017, P020)

The same approach discussed above is applied to the accident frequency analysis of these scenarios. This scenario applies to non-burstered munitions only based on the discussion of scenario P011.

Aircraft Direct Crash Damages the Outdoor Agent Piping System at TEAD; No Fire (P021, P022)

The present CAMDS facility at TEAD which will be modified to process bulk items only will have a separate building housing the TOX and the LIC. The two buildings will be connected by a 330 ft agent piping system to allow transfer of agent from the bulk drain station to the TOX. This pipe may be damaged by a both a large and small aircraft. The consequence is the same for both large and small aircraft crashes, hence the total aircraft crash frequency is the sum of the large and small aircraft crashes.

7.2.4. Earthquakes

The earthquake-initiated accident affecting the MHI is not a credible event since the current plan is to store unstacked munitions in onsite transportation containers in the MHI. The igloo is known to withstand very high intensity earthquakes and the only possibility for an agent release is if the munitions were to fall on a probe and be punctured. Since munitions will be stored in cylindrical containers and will not be stacked, puncture is not possible.

Several areas within the MDB are sensitive to earthquakes in the sense that damage to any of these areas could lead to a significant agent release. The areas of concern are: (1) the UPA where up to six onsite containers may be present; (2) the toxic cubicle (TOX) which houses two agent collection tanks, one of which may be completely full at the time of an earthquake; (3) the ventilation duct; (4) the agent piping system from the bulk drain station (BDS) to the TOX and from the TOX to the liquid incinerator (LIC); and (5) the fuel lines which could break and be ignited by earthquake-initiated electrical sparks.

Figures 7-43 and 7-44 show the event trees developed to identify relevant accident sequences in the MDB involving nonburstered and burstered munitions, respectively. Many event sequences have been screened out from further analysis based on the screening criteria described previously.

The accident sequences which survived the initial screening and have been analyzed further are listed in Table 7-6. Several more sequences were finally screened out after some analysis were performed on the basis of the frequency screening criterion of 10^{-10}/yr.

7.2.4.1. Earthquake Accident Analysis. The earthquake intensity is usually given in terms of maximum acceleration (i.e., g-level). There

is an approximate relationship between the Modified Mercalli Intensity (MMI) scale and the g-level. For example, MMI of VIII is approximately equivalent to 0.15 to 0.30 g.

7.1.4.2. Releases from Earthquake-Induced Accidents in the MDB. Sequences P025 to P034 involve the earthquake-initiated events inside the MDB. Lower intensity earthquakes may keep the munitions in the UPA as well as the agent collection tanks in the TOX intact but could initiate a fire that could subsequently cause the thermal detonation or hydraulic rupture of munitions in the UPA. Otherwise, high intensity earthquakes could cause munitions in the UPA to fall and be punctured, damage the agent collection tanks and the piping system, and also cause fire/explosion due to fuel line breaks. The events modeled are discussed below.

Releases Involving Bulk Containers

1. Earthquake Occurs. The initiating event (Event 1) in Fig. 7-43 is earthquake occurrence while bulk containers are being processed. To simplify the event tree evaluation, Event 1 further restricts the earthquake intensity to an acceleration range from g_l to g_u. Seven ranges are considered:

   a. 0.15 g to 0.2 g.
   b. 0.2 g to 0.3 g.
   c. 0.3 g to 0.4 g.
   d. 0.4 g to 0.5 g.
   e. 0.5 g to 0.6 g.
   f. 0.6 g to 0.7 g.
   g. Greater than 0.7 g.

   Earthquakes below 0.15 g are not considered in the analysis because the damage probabilities associated with such tremors

is negligibly small. Detailed examinations of seismic ranges above 0.7 g are unnecessary for the MDB because earthquakes above 0.7 g have a probability of almost 1.0 of damaging the MDB. With respect to the TOX, its high seismic design criterion precludes earthquake damage at frequencies above 10^{-10}/yr (see Section 4). Since release scenarios with frequencies below 10^{-10}/yr require no detailed examination, a detailed event tree analysis of seismic ranges above 0.7 g is also unnecessary relative to releases from the TOX.

The initiating event frequency at each site is the site-specific frequency at which earthquakes in the range, g_l to g_u, occur multiplied by the fraction of all bulk containers processed at the site. (Note: since this is classified information, the final frequency results will be adjusted accordingly in the classified appendix.). For an annual risk above ~3 x 10^{-5}/yr, the initiating event frequencies were taken from Fig. 4-11.

2. <u>MDB Not Damaged by the Earthquake</u>. MDB damage is defined as any loss of the MDB's agent containment capability. This includes damage to the MDB confinement walls or the ventilation system. As long as the MDB containment capability is maintained, any agent release inside the MDB (e.g., a release from a punctured munition) results in no appreciable release to the environment. Event 2 damage probabilities are based upon a generic study of damage to structures designed to the UBC.

The MDB (including the pipes and ducts) is designed to meet UBC seismic standards which means that the building is designed with a factor of safety and should not fail given an earthquake of a certain magnitude, depending on the site's seismic zone location. The CONUS facilities are being

designed for a minimum of seismic zone 2 design earthquakes, even though some of the sites may be in seismic zone 1 (i.e., APG, PBA, PUDA, and UMDA). ANAD, LBAD, and NAAP are in seismic zone 2 while TEAD is in seismic zone 3. Thus, the MDB at TEAD is designed to meet seismic zone 3 earthquake standards while the rest of the sites are designed to meet seismic zone 2 standards. The design level for a UBC structure with concrete walls (such as the MDB) is 0.14 g for seismic zone 3 and 0.07 g for seismic zone 2. The design safety factor is generally equal to 2. More details on the failure probabilities are presented in Appendix C.

3. Earthquake Impact on Munition Integrity. The munitions in the UPA represent a significant agent inventory. Event 3 addresses whether the earthquake causes a release from any of these munitions. Puncture is the dominant munition failure mode. The puncture probability is the probability that the earthquake causes an unpacked munition to fall from the conveyor or while it is being placed on the conveyor (this probability is conditionally dependent on seismic intensity) and that the fallen munition strikes a probe of sufficient size and density to penetrate it (the probe penetration probability is a function of munition type, see Ref. 7-5).

   Packed munitions are not stacked in the UPA. Ancillary studies indicate that the probability that a packed (or palletized) munition falls or is knocked over and strikes a probe of sufficient size to penetrate it (including penetrating any intervening packing material) is negligibly small relative to the 10^{-10}/yr screening criterion. Thus, only single munition punctures are addressed in Fig. 7-44.

4. TOX Integrity Maintained. The TOX, which may contain up to 500 gal of agent, also represents a potentially significant

release source. To minimize the potential of a release, the TOX room, tanks, and piping are being designed to meet the more stringent NRC standards and can survive earthquakes that engender MDB damage. The design g-level has not yet been determined but the intent is to ensure that the TOX will withstand relatively high g-forces. The same criteria will be applied to all sites regardless of the seismic zone location. For this analysis, it is assumed that the TOX will be designed for a 1-g safe shutdown earthquake (SSE) at all sites.

The high TOX design criterion virtually assures that TOX integrity will be maintained after all but the strongest (i.e., greater than 1 g) earthquakes. In order to quantify this contention, it is necessary to extrapolate the seismic hazard model in Fig. 4-11 to higher acceleration levels. This extrapolation is depicted in Fig. 7-45. The extrapolation is conservative for two reasons:

a. Linear logarithmic extrapolation results in the seismicity models for contour levels 0.05 through 0.20 intersecting the contour level 0.40 curve. Since the seismic hazard of a geological region is directly related to the associated contour level value, it is unlikely that the seismicity model for a region with a low hazard (e.g., a 0.10 contour level) will intersect the seismicity model for a region with a larger seismic hazard (e.g., a 0.20 contour level).

b. Most seismologists now believe that there is a physical upper limit to the amount of seismic energy that the earth can transmit. Although this upper limit depends upon site specific geological characteristics, for the MDB sites being considered it is estimated that this upper limit restricts ground acceleration to a maximum

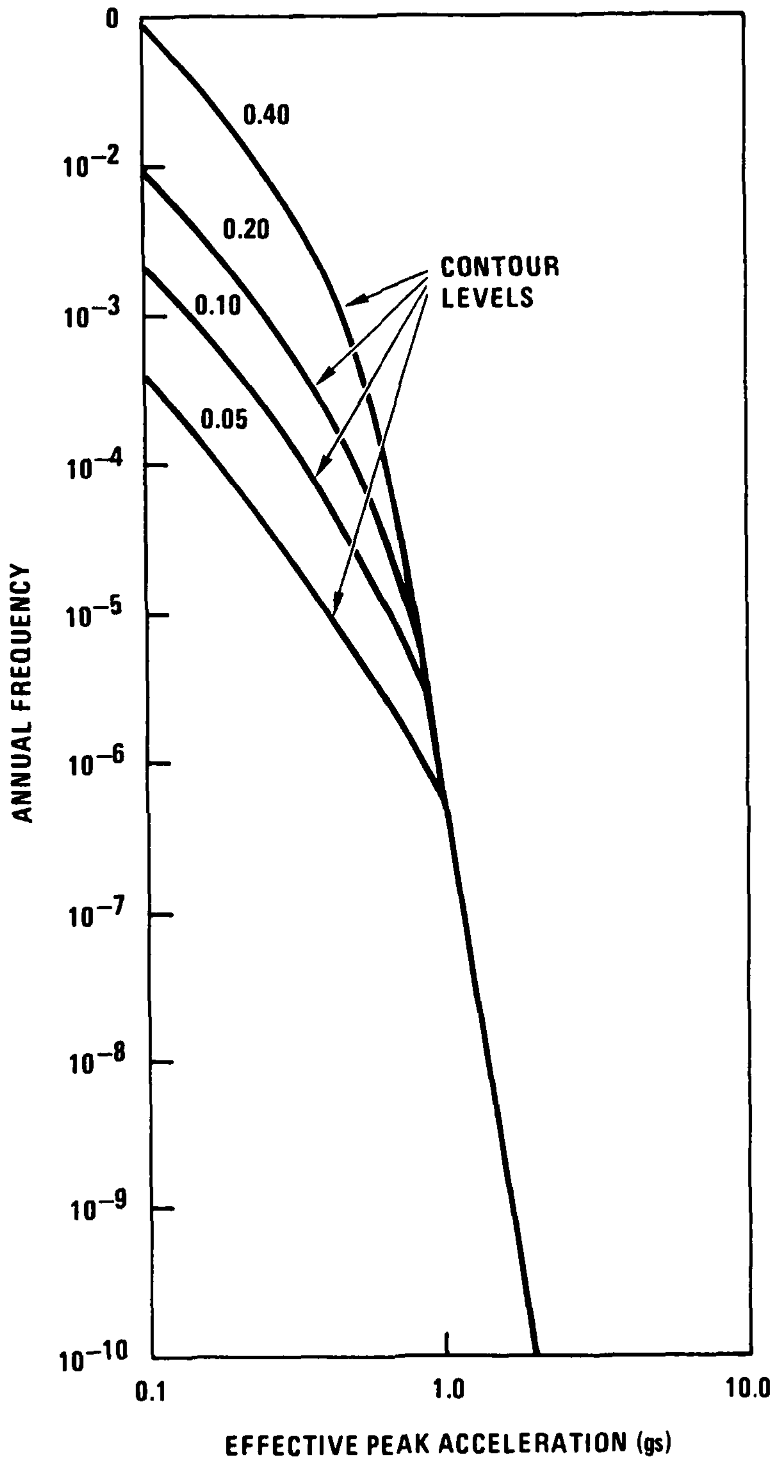

Fig. 7-45. Extrapolated seismic hazard model

value of around 0.6 to 0.8 g. Therefore, Fig. 7-45 is probably conservative by including effective peak accelerations above 0.8 g.

Figure 7-46 is the TOX fragility model corresponding to a 1 g SSE design (Appendix B includes the TOX fragility model derivation). By combining Figs. 7-45 and 7-46, it was determined that no event sequences involving TOX damage have a frequency of 10^{-10}/yr or greater.

5. Ignition Avoided. Available data indicate a high likelihood of earthquake-induced fires in both residential and commercial structures. Fig. 7-47 is the fault tree used to quantify the probability that an earthquake-initiated fire (or detonation) originates in the MDB.

Three mechanisms for ignition are identified. The first involves combustible material ignition by hot process equipment (e.g., a kiln or burner). Because of the high operating temperatures of this equipment, the ignition probability for Event X1 is essentially the probability that combustible material remains in contact with a hot surface long enough to ignite. If the MDB is not damaged by the earthquake the Event X1 probability is small relative to the probability of ignition from other mechanisms identified in Fig. 7-47. However, if the MDB is damaged by the earthquake, the Event X1 probability is essentially unity.

Natural gas ignition can result in either a fire or a detonation, depending upon the MDB integrity. If the MDB is intact, it is expected that detonation will result from a natural gas ignition. However, if the MDB is damaged by the earthquake, the buoyant natural gas cannot readily form a large detonable mass. Therefore, Fig. 7-47 models fire as the consequence of

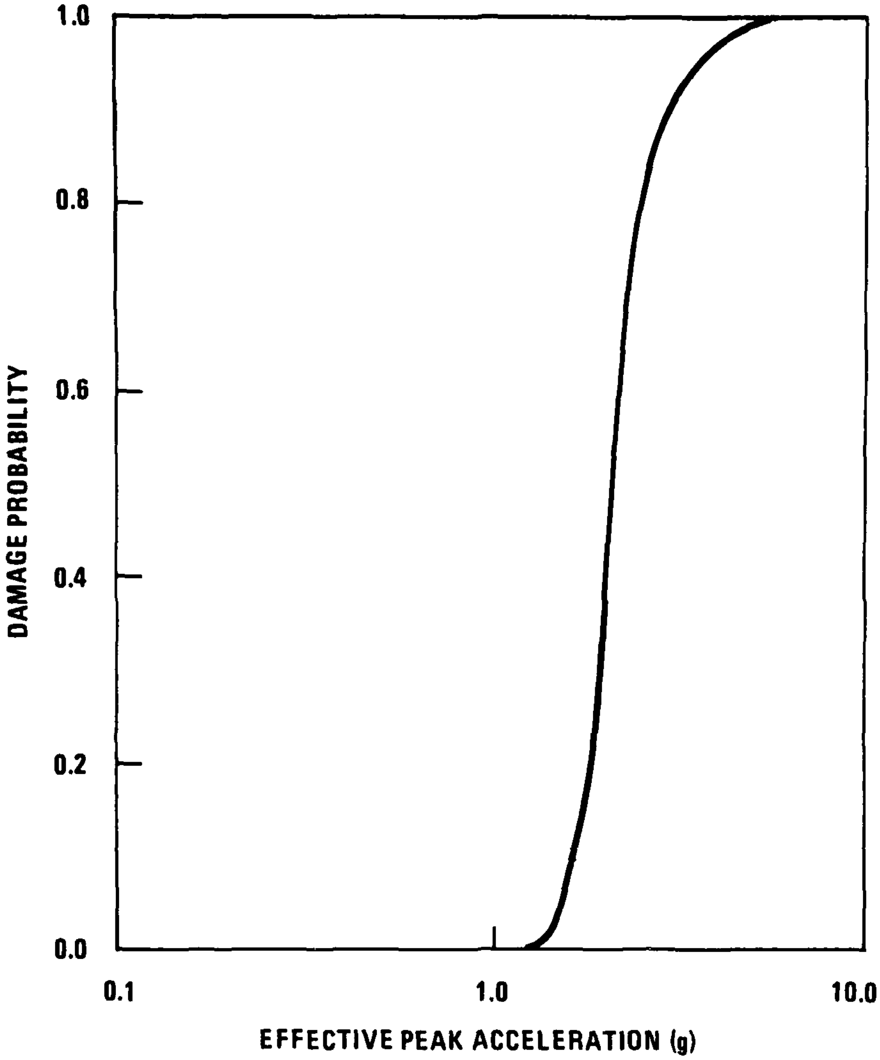

Fig. 7-46. TOX fragility model

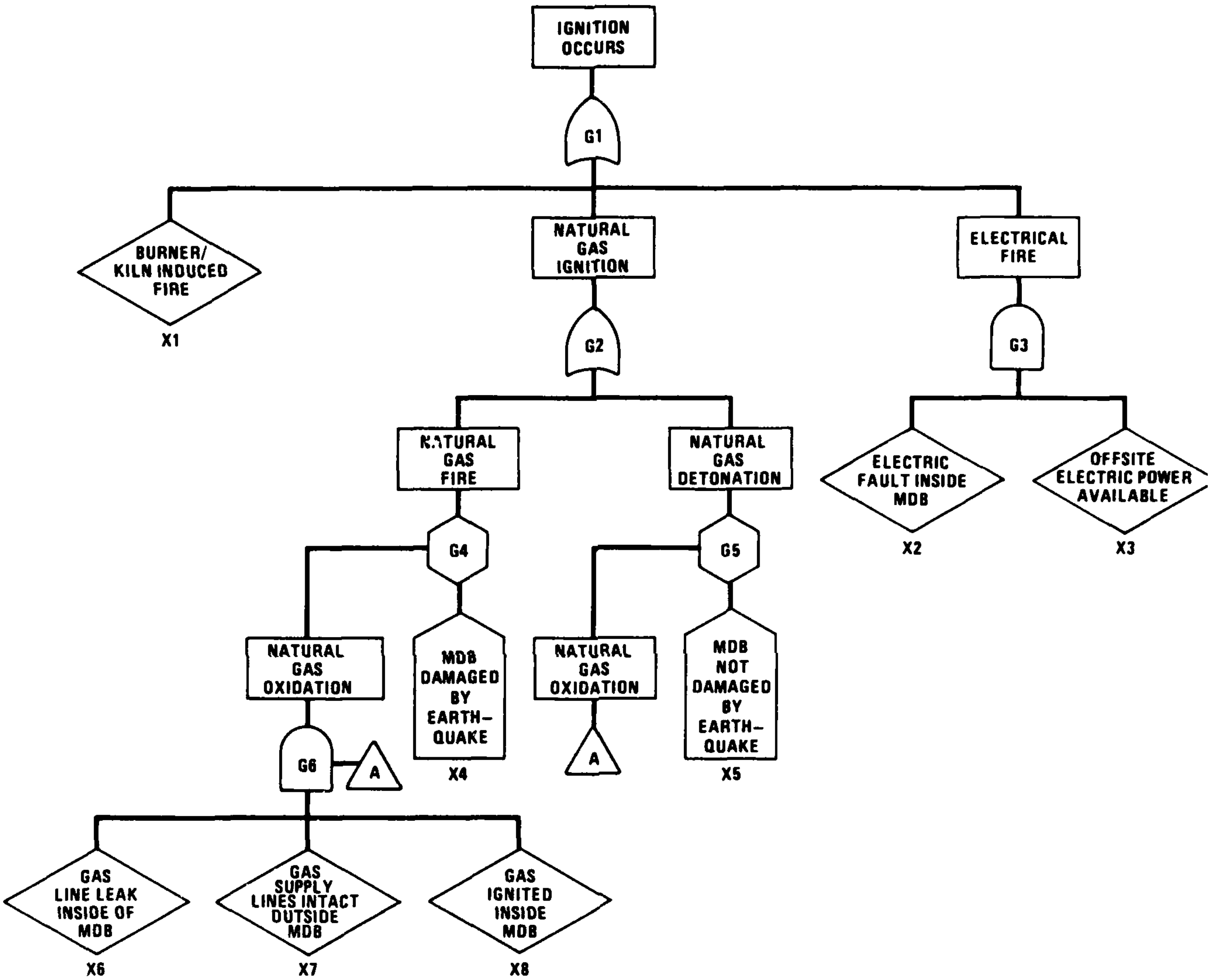

Fig. 7-47. Phenomenological fault tree for ignition occurrence

natural gas ignition when the MDB is damaged by the earthquake, and detonation as the consequence of natural gas ignition when the MDB is intact.

Three criteria must be satisfied for natural gas to ignite inside the MDB:

a. A natural gas line leak must occur inside the MDB.

b. A supply of natural gas must be available from the external distribution system.

c. An ignition source is required.

The third ignition mechanism addressed in Fig. 7-47 is an electrical fire. The conditions necessary for an electrical fire are:

a. An electrical fault (i.e., arcing) inside the MDB.

b. A supply of electric power to the faulted equipment.

Event X3 is an important factor in evaluation Fig. 7-47 because available data indicate that offsite power can be lost at a relatively low seismic intensity.

6. Fire Suppression Successful. Successful fire suppression is defined as extinguishing a fire before it increases the amount of agent available for release to the environment. The UPA and TOX are the major areas of concern. Since the TOX tank is vented, over pressurization is not a problem. Moreover, the temperatures produced by a fire are insufficient to directly fail the tank or agent piping. Hence, the principal concern is thermal failure of munitions in the UPA.

Fig. 7-48 is the fire suppression success tree. If the fire originates in the UPA (Event X1), 30 min are available to

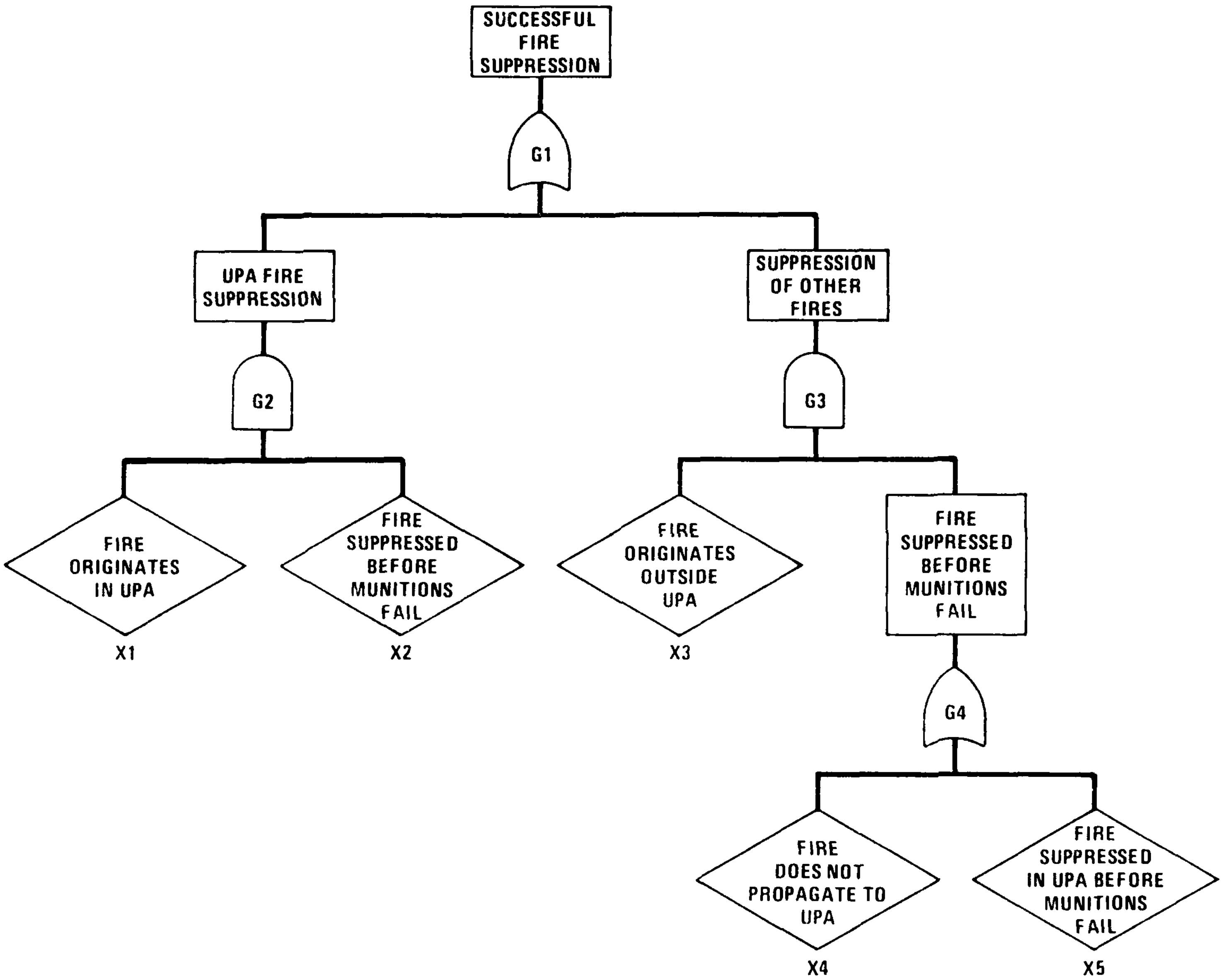

Fig. 7-48. Phenomenological success tree for fire suppression

suppress it before the bulk containers fail. If the MDB is intact (i.e., it has not been damaged by either the earthquake or a natural gas detonation), applicable data indicate a 76% chance of successfully suppressing the fire. If the MDB is damaged, the likelihood of suppressing a UPA fire within 30 min is effectively zero.

Fires that originate outside the UPA must propagate to the UPA and burn for 30 min before any bulk containers fail (Gate G3 in Fig. 7-48). If the MDB is intact, the fire walls preclude the propagation to the UPA. If the MDB is damaged by the earthquake, the probability of Event X4 is predicated upon extrapolating a fire propagation model developed for nuclear power plants, and is a function of the distance from the fire to the UPA. Finally, if the MDB is damaged by a natural gas detonation, successful fire suppression is conservatively ignored.

Event 6 is quantified with respect to whether the fire damages any containers in the UPA. However, if agent is released from the TOX, the dispersion mechanism is dependent upon agent combustion. Agent dispersion with combustion occurs only if any one of the following conditions is satisfied:

a. Natural gas detonation occurs.
b. The TOX and MDB are both damaged and a fire occurs.

Releases Involving Burstered Munitions

The salient differences between Figs. 7-43 and 7-44 relate to Events 1, 3, 5, and 6. The initiating event frequency (Event 1) in Fig. 7-34 is the site-specific frequency at which earthquakes in the range, g_l to g_u, occur multiplied by the fraction of all munitions that

will be processed at the site that are burstered (this will be given in the classified appendix).

In addition to puncture, detonation is an important failure mode when burstered munitions are being processed (Event 3, Fig. 7-44). If the earthquake causes a munition detonation in the UPA, the probabilities of ignition and successful fire suppression (Events 5 and 6) are altered. Specifically, the conditional ignition probability is unity, subsequent to a munition detonation in the UPA. Moreover, a munition detonation in the UPA essentially precludes successful fire suppression. If the earthquake causes a fire but does not directly detonate any munitions, the fire suppression probability is quantified with the Fig. 7-12 success tree. However, the time available to suppress the fire is only 10 min for burstered munitions and there is no intervention from plant personnel or site fire fighters.

Uncertainties for the MDB earthquake events were evaluated as follows:

Event 1: Earthquake Occurs

The uncertainty in the initiating event frequency is represented by a lognormal distribution with an uncertainty factor of 10 and a median value equal to the point frequency estimate. This is predicated upon the generic guidelines issued for the uncertainty assessment (see Table 5-21).

Event 2: MDB Not Damaged by the Earthquake

Uncertainty factors for MDB damage probabilities above 0.1 will also be taken from Table 5-21. For failure probabilities below 0.1 an uncertainty factor of 3 is assigned. The uncertainty distribution in each case is lognormal with a median equal to the MDB failure probability.

Event 3: Earthquake Impact on Munition Integrity

Table 5-21 recommendations for probabilities of 0.1 or greater are applicable to the uncertainty in the probability that a munition falls from the conveyor. An uncertainty factor of 5 is applied to P_p - the conditional probability that a munition is punctured subsequent to a fall. Since all event sequences involving a munition detonation have frequencies below 10^{-10}/yr, they require no uncertainty analysis. The uncertainty distributions for the Event 3 parameters are lognormal with medians equal to the point probability estimates.

Event 4: TOX Integrity Maintained

Uncertainty factors for TOX damage probabilities above 0.1 will also be taken from Table 5-21. For failure probabilities below 0.1 an uncertainty factor of 3 is assigned. The uncertainty distribution in each case is lognormal with a median equal to the TOX failure probability.

Event 5: Ignition Avoided

The Event 5 uncertainty results from the uncertainties in the following functions and parameter.

1. $f_{X2}(x) \rightarrow$ probability density function for inside pipe failure.

2. $f_{X3}(x) \rightarrow$ probability density function for underground pipe failure.

3. $Pr(X_4) \rightarrow$ natural gas ignition probability.

4. $f_{X5L}(x) \rightarrow$ probability density function for light fixture failure.

5. f_{X5I} (x) → probability density function for industrial circuit failure.

6. f_{X6} (x) → probability density function for offsite power loss.

In general:

$$f_J (x) = \frac{1}{\beta_{R,J} \times \sqrt{2\pi}} \exp \frac{-[\ln(x) - \ln(\alpha_J \, \epsilon_{U,J})]^2}{2\beta^2_{R,J}}$$

Moreover, the uncertainty in each Event 5 fragility is a function of the uncertainty on $\epsilon_{U,J}$, as was described previously for warehouse fires. From Table 5-20, the uncertainty factors for $\epsilon_{U,X5L}$ and $\epsilon_{U,x6}$ are 2 and 1.5, respectively. Uncertainty factors for $\epsilon_{U,X2}$ and $\epsilon_{U,X5I}$ are from the Zion amd Seabrook PRAs. The value of $\epsilon_{U,X2}$ is directly applicable to the MDB, but the uncertainty factor for $\epsilon_{U,X51}$ is obtained from the Seabrook data plus an additional factor of 2 that arises from concerns about the applicability of a nuclear data base on the MDB design.

The major uncertainty in $\epsilon_{U,X3}$ is due to applying a generic Modified Mercalli fragility model to the MDB. Depending upon the actual soil conditions and pipeline characteristics, the median failure threshold can vary about the nominal value by a factor of 2. Thus, an uncertainty factor of 2 is adopted for $\epsilon_{U,X3}$.

Approximately a binominal distribution with a normal distribution, the uncertainty factor for Pr (X4) is 1.5. A lognormal distribution is modeled. These results are tabulated in Table 7-10.

<u>Event 6</u>: Fire Suppression Successful

The uncertainty in most fire suppression model functions and parameters (e.g., the probability of a pipe failure or loss of offsite

TABLE 7-10
EVENT 5 STATISTICAL PARAMETERS

Parameter	Median	Uncertainty Factor
$\epsilon_{U,X2}$	1	2.2
$\epsilon_{U,XE}$	1	2.0
Pr (X4)	0.0067	1.5
$\epsilon_{U,X5L}$	1	2.0
$\epsilon_{U,X5I}$	1	2.8
$\epsilon_{U,X6}$	1	1.5

power) was previously addressed for Event 5. Only three additional parameters require uncertainty models:

1. Operator error probability.
2. Damper failure probability.
3. Fire suppression failure probability.

According to information from Battelle-Columbus, the uncertainty in the operator error probability is lognormally distributed with an uncertainty factor of 10 and a median equal to the error probability. Data in EGG-EA5887 support a similar model for the damper failure probability. The fire propagation probability has a lognormal distribution with an uncertainty factor of 3 for fires originating outside of the UPA. For fire suppression inside the UPA the Table 5-21 guidelines are recommended. In both cases the nominal probabilities represent distribution medians.

7.2.4.3. Earthquake-Induced Releases Involving the Outdoor Agent Piping System at TEAD. The analysis of the earthquake scenarios involving the MDB for the modified CAMDS facility at TEAD includes the rupture of the agent piping system between the BDS and the TOX at TEAD. The agent pipe line is assumed to be double walled and approximately 330 ft long. The analysis also assumes that this pipe will be designed to NRC standards which means that the pipe should not fail at 1.0-g earthquake.

7.2.5. Quantification of Logic Models

The data base used for the quantification of the external event sequences are presented in Table 7-9 and in Tables 7-11 through 7-13.

7.2.5.1. Tornado Accident Frequencies. The data base used for the accident scenario analysis is listed in Table 7-9. The site-specific tornado frequency versus velocity curves have been presented in Section 4. Two types of missiles were initially considered: a (1) 3-in.

TABLE 7-11
DATA BASE FOR METEORITE INITIATED PLANT ACCIDENT SEQUENCES

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Data Base For Meteorite Initiated Plant Accident Scenarios

Event	Site	Munition / structure	Variable	Input Data	Error	Reference
1. Frequency of meteorite strike (events/sq-ft-yr)	All	All	METEOR	6.4E-13	1.0E+01	Ref. 7-8
2. Probability munition in igloo breached	All	Bomb	MEIB	2.4E-06	1.0E+01	See calc sheets (Ref. 7-3)
		4.2-in mort	MEID	1.6E-06		
		105-mm catrg	MEIC	9.7E-07		
		ton contnr	MEIK	3.3E-06		
		mine	MEIM	2.4E-06		
		155-mm proj	MEIP	7.4E-07		
		8-in proj	MEIQ	7.4E-07		
		rocket	MEIR	3.3E-06		
		sp. tank	MEIS	5.6E-06		
3. Probability munition in UPA breached	All	Bomb	MEUPB	7.9E-04	1.0E+01	See calc sheets (Ref. 7-3)
		4.2-in mort	MEUPD	5.5E-04		
		105-mm catrg	MEUPC	3.0E-04		
		ton contnr	MEUPK	1.1E-03		
		mine	MEUPM	7.9E-04		
		155-mm proj	MEUPP	2.4E-04		
		8-in proj	MEUPQ	2.4E-04		
		rocket	MEUPR	1.1E-03		
		sp. tank	MEUPS	1.8E-03		
4. Probability TOX is breached	All	All	METOX	1.2E-05	1.0E+01	Ref. 7-3
5. Probability outside agent pipe breached	TEAD	Pipe	MEPIPE	7.2E-02	5.0E+00	Ref 7-3
6. Target area (sq-ft)	All	Igloo	IGL	9.6E+02	none	Ref. 7-3
		UPA	UPA	5.7E+03	none	
		TOX	MDB	4.4E+04	none	
		Pipe	PIPE	6.6E+02	none	

TABLE 7-12
EFFECTIVE TARGET AREA FOR AIRCRAFT CRASH ANALYSIS

Effective Target Area (Sq-Mi) Direct Crash

SITE (B)	VARIABLE NAME (C)	AREA (SQ-MI) (D)
80-FT IGLOO	IGL80DR	7.60E-05
MDB	MDBDR	1.77E-03
CAMDS_PIPE	CDSPI	1.18E-03

Effective Target Area (Sq-Mi) Indirect Crash

SITE (B)	VARIABLE NAME (C)	AREA (SQ-MI) (D)
80-FT IGLOO	IGL80IR	7.26E-03
MDB	MDBIR	1.22E-02

TABLE 7-13
AIRCRAFT CRASH DATA

Data base FOR AIRCRAFT CRASH INITIATED SCENARIOS FOR PLANT OPERATIONS

EVENT	VARIABLE ID	FREQUENCY OR PROBABILITY	UNIT	ERROR FACTOR	REFERENCE
1. Large aircraft crash (direct) onto MDB					
[illegible]	[illegible]	1.4E-08	per facility	10	Ref. 7-3
[illegible]	[illegible]	9.4E-10	yr	10	
[illegible]	[illegible]	6.0E-07		10	
[illegible]	[illegible]	8.1E-09		10	
[illegible]	[illegible]	2.7E-07		10	
[illegible]	[illegible]	1.0E-07		10	
[illegible]	[illegible]	6.4E-10		10	
[illegible]	[illegible]	2.6E-08		10	
2. Large aircraft crash (indirect) onto MDB					
[illegible]	[illegible]	9.6E-08	per facility	10	Ref. 7-3
[illegible]	[illegible]	6.5E-07	yr	10	
[illegible]	[illegible]	5.5E-08		10	
[illegible]	[illegible]	5.6E-08		10	
[illegible]	[illegible]	1.8E-08		10	
[illegible]	[illegible]	7.2E-07		10	
[illegible]	[illegible]	4.4E-09		10	
[illegible]	[illegible]	1.4E-07		10	
3. Large aircraft crash (direct) onto MHI					
[illegible]	[illegible]	6.0E-10	per facility	10	Ref. 7-3
[illegible]	[illegible]	4.0E-11	yr	10	
[illegible]	[illegible]	3.4E-10		10	
[illegible]	[illegible]	5.5E-10		10	
[illegible]	[illegible]	1.1E-10		10	
[illegible]	[illegible]	4.5E-09		10	
[illegible]	[illegible]	2.7E-11		10	

TABLE 7-13 (Continued)

DATA BASE FOR AIRCRAFT CRASH-INITIATED SCENARIOS FOR PLANT OPERATIONS

EVENT (O)	VARIABLE ID (P)	FREQUENCY OR PROBABILITY (Q)	UNIT (R)	ERROR FACTOR (S)	REFERENCE (T)
UMDA	DIUM	1.1E-09		10	
4. Large aircraft crash (indirect) onto MHI					
ANAD	AIAN	5.7E-08	per facility	10	Ref. 7-[illegible]
APG	AIAP	3.8E-09	yr	10	
LBAD	AILB	3.3E-08		10	
NAAP	AINA	3.3E-08		10	
PBA	AIPB	1.1E-08		10	
PUDA	AIPU	4.3E-07		10	
TEAD	AITE	2.6E-09		10	
UMDA	AIUM	1.1E-07		10	
5. MDB breached given direct crash					
	BD	1.0E+00	none	none	EJ
6. MDB breached given indirect crash					
	BA	1.7E-01	none	2	Ref. 7-[illegible]
7. MHI breached given direct crash					
	ID	8.0E-01	none	1.4	EJ
8. MHI breached given indirect crash					
	IA	2.0E-03	none	[illegible]	Ref. 7-[illegible]
9. Crash does not involve fire					
	NF	5.5E-01	none	none	Ref. [illegible]
13. Crash results in fire					
	YF	4.5E-01	none	none	Ref. [illegible]
14. Fire not contnd in 1/2 hr (burstrd) direct crash					
	FNCB	1.0E+00	none	none	Ref. [illegible]
15. Fire contnd in 1/2 hr (nonburstrd direct and indirect)					
	FCNB	3.4E-04	none	[illegible]	Ref. 7-[illegible]

TABLE 7-13 (Continued)

(O)	(P)	(Q)	(R)	(S)	(T)
DATA BASE FOR AIRCRAFT CRASH-INITIATED SCENARIOS FOR PLANT OPERATIONS					
EVENT	VARIABLE ID	FREQUENCY OR PROBABILITY	UNIT	ERROR FACTOR	REFERENCE
(O)	(P)	(Q)	(R)	(S)	(T)
16. Fire not contnd in 1/2 hr (nonburstrd)	FNCNB	1.0E+00	none	none	Ref. 7-3
17. Aircraft crash onto outdoor pipe at CAMDS	LDCD	1.8E-08	none	10	Ref. 7-3

pipe and a (2) utility pole. For all munition types, it was found that the utility pole had a higher probability of penetrating munitions in the UPA and the igloo (with a steel door). Hence the data shown in Table 7-9 apply only to the cases where a utility pole was the missile. Also shown in the table are the error factors assigned to each variable. In many cases there was insufficient statistical information to adequately assess the data uncertainty and, therefore, the assignment of error factors was by engineering judgment. The results of the accident frequency analysis are presented in Table 7-14. All the accident scenarios were screened out on the basis of 1 x 10^{-10})/yr frequency criterion.

7.2.5.2. <u>Meteorite Strike Frequencies</u>. The data base used for the accident scenario analysis is presented in Table 7-11. More details on the derivation of these values are given in the calculation sheets (Ref. 7-5). The results of the accident frequency analysis are presented in Table 7-14. As indicated in the results, the frequencies of meteorite-initiated accidents for all scenarios are below 10^{-10}/yr and hence these scenarios have been screened out from further analysis.

7.2.5.3. <u>Aircraft Crash Frequencies</u>. The data used in the analysis of the aircraft crash accidents are presented in Tables 7-12 and 7-13. The derivation of the aircraft crash frequency values at each site has been discussed in Section 4. The results of the analysis are shown in Table 7-14. The following scenarios can be screened out on the basis of the 1.0 x 10^{-10}/yr:

P011 - Direct large aircraft crash onto the MHI; fire contained in 0.5 h.

P014 - Direct large aircraft crash onto the MDB; fire contained in 0.5 h.

P015 - Indirect large aircraft crash onto the MHI; no fire.

TABLE 7-14
PLANT OPERATIONS EXTERNAL EVENT FREQUENCY DATA

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F01 - Tornado-generated missile puncture/crush munitions in the MHI.																	
FOBGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-16	9.4E+01	1.2E-15	9.4E+01
FODHC	1	8.0E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	7.3E-14	9.4E+01	1.3E-15	9.4E+01	N/A	--
FOCGC	1	2.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.3E-16	9.4E+01	N/A	--
FOCHC	1	2.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-14	9.4E+01	N/A	--	N/A	--
FOFGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-16	9.4E+01	N/A	--
FOFHC	1	1.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	3.1E-13	9.4E+01	N/A	--	2.0E-16	9.4E+01	7.7E-16	9.4E+01
FOFVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-16	9.4E+01	N/A	--
FOMVC	1	9.5E-13	9.4E+01	N/A	--	N/A	--	N/A	--	1.3E-12	9.4E+01	N/A	--	1.5E-15	9.4E+01	5.8E-15	9.4E+01
FOPGC	1	2.8E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.7E-16	9.4E+01	4.8E-15	9.4E+01
FOPHC	1	2.8E-13	9.4E+01	N/A	--	4.9E-13	9.4E+01	N/A	--	N/A	--	3.8E-14	9.4E+01	5.7E-16	9.4E+01	N/A	--
FOPVC	1	2.8E-13	9.4E+01	N/A	--	4.9E-13	9.4E+01	N/A	--	N/A	--	N/A	--	5.7E-16	9.4E+01	4.8E-15	9.4E+01
FOGGC	1	2.8E-13	9.4E+01	N/A	--	5.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	6.8E-16	9.4E+01	5.8E-15	9.4E+01
FOGVC	1	2.8E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.8E-16	9.4E+01	5.8E-15	9.4E+01
FORGC	1	8.6E-13	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.4E-15	9.4E+01	5.8E-15	9.4E+01
FORVC	1	8.6E-13	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.4E-15	9.4E+01	5.8E-15	9.4E+01
FOSVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.7E-16	9.4E+01	3.5E-15	9.4E+01
Tornado-generated missile detonate munitions in the MHI.																	
FOCHC	2	1.7E-13	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-14	--	2.8E-16	9.9E+01	N/A	--
FOCGC	2	4.5E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.1E-17	9.9E+01	N/A	--
FOCHC	2	4.5E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.1E-15	9.9E+01	N/A	--	N/A	--
FOMVC	2	2.0E-13	9.9E+01	N/A	--	N/A	--	N/A	--	2.7E-13	9.9E+01	N/A	--	3.3E-16	9.9E+01	3.3E-16	9.9E+01
FO-GC	2	5.9E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-17	9.9E+01	1.2E-16	9.9E+01
FOPHC	2	5.9E-14	9.9E+01	N/A	--	1.0E-13	9.9E+01	N/A	--	N/A	--	8.0E-15	9.9E+01	1.2E-16	9.9E+01	N/A	--
FOPVC	2	5.9E-14	9.9E+01	N/A	--	1.0E-13	9.9E+01	N/A	--	N/A	--	N/A	--	1.2E-16	9.9E+01	1.2E-17	9.9E+01
FOGGC	2	5.9E-14	9.9E+01	N/A	--	1.2E-13	9.9E+01	N/A	--	N/A	--	N/A	--	1.4E-16	9.9E+01	1.4E-16	9.9E+01
FOGVC	2	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-16	9.9E+01	1.4E-16	9.9E+01
FORGC	2	1.8E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	3.0E-16	9.9E+01	3.0E-16	9.9E+01
FORVC	2	1.8E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	3.0E-16	9.9E+01	3.0E-16	9.9E+01
Tornado-generated missile puncture/crush munitions in the UPA.																	

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOBGC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.1E-15	9.4E+01	2.1E-15	9.4E+01
FOBHC	3	6.6E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-13	9.4E+01	7.9E-15	9.4E+01	N/A	--
FOCGC	3	2.3E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-15	9.4E+01	N/A	--
FOCHC	3	2.3E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-13	9.4E+01	N/A	--	N/A	--
FOFGC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.6E-15	9.4E+01	N/A	--
FOFHC	3	3.6E-12	9.4E+01	2.2E-13	9.4E+01	N/A	--	N/A	--	3.6E-12	9.4E+01	N/A	--	3.6E-15	9.4E+01	1.1E-15	9.4E+01
FOFVC	3	N/A	--	N/A	--	N/A	--	3.6E-12	9.4E+01	N/A	--	N/A	--	3.6E-15	9.4E+01	N/A	--
FOMVC	3	6.0E-13	9.4E+01	N/A	--	N/A	--	N/A	--	7.7E-12	9.4E+01	N/A	--	9.2E-15	9.4E+01	7.9E-15	9.4E+01
FOFGC	3	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	8.8E-15	9.4E+01
FOFHC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	4.9E-13	9.4E+01	4.1E-15	9.4E+01	N/A	--
FOFVC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	8.8E-15	9.4E+01
FOGGC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	9.2E-15	9.4E+01
FOGVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	9.2E-15	9.4E+01
FORGC	3	7.1E-12	9.4E+01	N/A	--	7.1E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	8.5E-15	9.4E+01	4.1E-15	9.4E+01
FORVC	3	7.1E-12	9.4E+01	N/A	--	7.1E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	8.5E-15	9.4E+01	4.1E-15	9.4E+01
FOSVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-14	9.4E+01	4.1E-15	9.4E+01
Tornado-generated missile detonate munitions in the UPA.																	
FODHC	4	7.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-14	9.4E+01	8.5E-16	9.4E+01	N/A	--
FOCGC	4	2.4E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-16	9.4E+01	N/A	--
FOCHC	4	2.4E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-14	9.4E+01	N/A	--	N/A	--
FOMVC	4	8.2E-13	9.4E+01	N/A	--	N/A	--	N/A	--	8.2E-13	9.4E+01	N/A	--	9.8E-16	9.4E+01	9.8E-16	9.4E+01
FOFGC	4	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01
FOFHC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	2.5E-14	9.4E+01	4.4E-16	9.4E+01	N/A	--
FOFVC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01
FOGGC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01
FOGVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01
FORGC	4	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	4.4E-16	9.4E+01	9.1E-16	9.4E+01
FORVC	4	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	4.4E-16	9.4E+01	9.1E-16	9.4E+01
FOS - Tornado-generated missile damages the agent piping system between the BDS and TOX at TEAD (bulk-only facility).																	
FOPGS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOAHS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--
FOAVS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--

Notes:

1. Frequency unit = events/operating year
2. Scenario 5 applies only to the TEAD bulk-only facility

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TABLE 7-14 (Continued)

FLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F06 - Meteorite strikes the MHI.																	
FOBGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-15	2.6E+01	1.4E-15	2.6E+01
FOGHC	6	9.8E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-16	2.6E+01	9.8E-16	2.6E+01	N/A	--
FOCGC	6	6.0E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-16	2.6E+01	N/A	--
FOCHC	6	6.0E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-16	2.6E+01	N/A	--	N/A	--
FONGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--
FONHF	6	2.0E-15	2.6E+01	2.0E-15	2.6E+01	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	2.0E-15	2.6E+01	2.0E-15	2.6E+01
FONVF	6	N/A	--	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--
FOMVC	6	1.5E-15	2.6E+01	N/A	--	N/A	--	N/A	--	1.5E-15	2.6E+01	N/A	--	1.5E-15	2.6E+01	1.5E-15	2.6E+01
FOFGC	6	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01
FOFHC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	N/A	--
FOFVC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01
FOLGC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01
FOCVC	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01
FORGC	6	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	2.1E-15	2.6E+01
FORVC	6	3.4E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	2.1E-15	2.6E+01
FOSVF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.4E-15	2.6E+01	3.4E-15	2.6E+01
F07 - Meteorite strikes the UPA.																	
FOBGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	2.6E+01	2.9E-12	2.6E+01
FOLHC	7	2.0E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-12	2.6E+01	2.0E-12	2.6E+01	N/A	--
FOCGC	7	1.1E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-12	2.6E+01	N/A	--
FOCHC	7	1.1E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-12	2.6E+01	N/A	--	N/A	--
FONGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--
FONHF	7	4.0E-12	2.6E+01	4.0E-12	2.6E+01	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01
FONVF	7	N/A	--	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--
FOMVC	7	2.9E-12	2.6E+01	N/A	--	N/A	--	N/A	--	2.9E-12	2.6E+01	N/A	--	2.9E-12	2.6E+01	2.9E-12	2.6E+01
FOPGC	7	8.8E-13	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01
FOPHC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	N/A	--
FOPVC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01
FOSGC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOGVC	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01
FOAGC	7	4.0E-12	2.6E+01	N/A	--	4.0E-12	1.7E+01	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01
FOAVC	7	4.0E-12	2.6E+01	N/A	--	4.0E-12	1.7E+01	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01
FOGVF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.7E-12	2.6E+01	6.7E-12	2.6E+01
F07A - Meteorite strikes the TOX.																	
FOAGF	7A	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01
FOAHF	7A	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01
FOAVF	7A	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01
F08 - Meteorite strikes the agent piping system between the BOS and TOX at TEAD (bulk-only facility).																	
FOAGF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--
FOAHF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--
FOAVF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--

Notes:

1. Frequency unit = events/operating year
2. Scenario 8 applies only to the TEAD bulk-only facility

TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F09 - Direct large aircraft crash onto the MHI; no fire																	
FOBGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FODHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	--
FOCGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--
FOCHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	N/A	--	N/A	--
FOKGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--
FOKHS	9	2.6E-10	1.0E+01	1.8E-11	1.0E+01	N/A	--	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOKVS	9	N/A	--	N/A	--	N/A	--	1.50E-10	1.0E+01	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--
FOMVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOPGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOPHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	--
FOPVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOQGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOQVC	9	N/A	--	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FORGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FORVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
FOSVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01
F010 - Direct large aircraft crash onto the MHI; fire not contained in 0.5 hours																	
FOBGF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FODHC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	4.1E-11	1.0E+01	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	--
FOCGC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--
FOCHC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-09	1.0E+01	N/A	--	N/A	--
FOKGF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--
FOKHF	10	2.2E-10	1.0E+01	1.4E-11	1.0E+01	N/A	--	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FOKVF	10	N/A	--	N/A	--	N/A	--	1.3E-10	1.0E+01	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--
FOMVC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FOPGC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FOPHC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	--
FOPVC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FOQGC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	N/A	--

See notes at end of table.

TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOQVC	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FORGC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FORVC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01
FOSVF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--
FO11 - Direct large aircraft crash onto the MHI; fire contained in 0.5 hours																	
FOBGF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--
FOIGF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--
FOKHF	11	7.3E-14	1.3E+01	4.90E 15	1.3E+01	N/A	--	N/A	--	1.4E-14	1.3E+01	N/A	--	3.3E-15	1.3E+01	1.4E-13	1.3E+01
FOKVF	11	N/A	--	N/A	--	N/A	--	4.30E-14	1.3E+01	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--
FOSVF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	1.4E-13	1.3E+01
FO12 - Direct large aircraft crash damages the MDB; no fire																	
FOBGS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FODHC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.5E-09	1.0E+01	5.7E-08	1.0E+01	3.5E-10	1.0E+01	N/A	--
FOCGC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--
FOCHC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.7E-08	1.0E+01	N/A	--	N/A	--
FOFGS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--
FOFHS	12	7.7E-09	1.0E+01	5.1E-10	1.0E+01	N/A	--	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FOIVS	12	N/A	--	N/A	--	N/A	--	4.5E-09	1.0E+01	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--
FOMVC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FOFGC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FOFHC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	5.7E-08	1.0E+01	3.5E-10	1.0E+01	N/A	--
FOFVC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FOQGC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	N/A	--
FOQVC	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FORGC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FORVC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01
FOSVS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--
FO13 - Direct large aircraft crash damages the MDB; fire not contained in 0.5 hours																	
FOBGF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FODHC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-09	1.0E+01	4.7E-08	1.0E+01	2.9E-10	1.0E+01	N/A	--

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	AFG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOCGC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--
FGCHC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-08	1.0E+01	N/A	--	N/A	--
FOKGF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--
FOKHF	13	6.3E-09	1.0E+01	4.2E-10	--	N/A	--	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FOKVF	13	N/A	--	N/A	--	N/A	--	3.6E-09	1.0E+01	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--
FOMVC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FOFGC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FOFHC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	4.7E-08	1.0E+01	2.9E-10	1.0E+01	N/A	--
FOFVC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
POOGC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	N/A	--
FOOVC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FORGC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FORVC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01
FOSVF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--
F014 - Direct large aircraft crash damages the MDB; fire contained in 0.5 hours																	
FOBGF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01
FOKGF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	N/A	--
FOKHF	14	2.1E-12	1.3E+01	1.4E-13	1.3E+01	N/A	--	N/A	--	4.1E-13	1.3E+01	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01
FOKVF	14	N/A	--	N/A	--	N/A	--	1.2E-12	1.3E+01	N/A	--	N/A	--	9.7E-14	1.3E+01	N/A	--
FOSVF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01
F015 - Indirect large aircraft crash damages the MHI; no fire																	
FOGGS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FODHC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-10	1.3E+01	2.9E-12	1.3E+01	N/A	--
FOCGC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--
FOCHC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-10	1.3E+01	N/A	--	N/A	--
FOKGS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--
FOFHS	15	6.3E-11	1.3E+01	4.20E-12	1.3E+01	N/A	--	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FOKVS	15	N/A	--	N/A	--	N/A	--	3.70E-11	1.3E+01	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--
POMVC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FOFGC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01

See notes at end of table.

TABLE 7-14 (Continued)

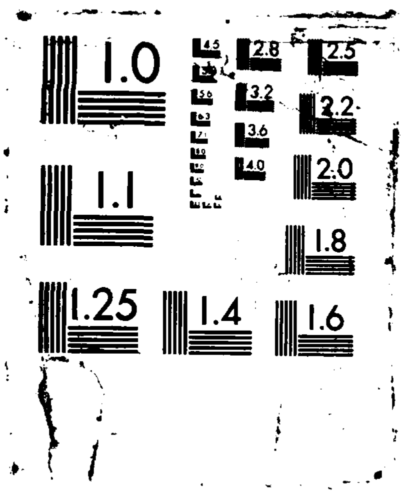
PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOFHC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	4.7E-10	1.3E+01	2.9E-12	1.3E+01	N/A	--
FOFVC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FOOGC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FOGVC	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FORGC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FORVC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
FOSVS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01
F016 Indirect large aircraft crash damages the MHI; fire not contained in 0.5 hours																	
FOBGF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01
FODHC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-10	1.3E+01	2.4E-12	1.3E+01	N/A	--
FOCGC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	N/A	--
FOCHC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-10	1.3E+01	N/A	--	N/A	--
FOFGF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	N/A	--
FOFHF	16	5.1E-11	1.3E+01	3.50E-12	1.3E+01	N/A	--	N/A	--	9.8E-12	1.3E+01	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01
FOFVF	16	N/A	--	N/A	--	N/A	--	3.00E-11	1.3E+01	N/A	--	N/A	--	2.3E-12	1.3E+01	N/A	--
FOMVC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FOFGC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FOFHC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	3.9E-10	1.3E+01	2.4E-12	1.3E+01	N/A	--
FOFVC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FOGGC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FOGVC	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FORGC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FORVC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01
FOSVF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01
F017 Indirect large aircraft crash damages the MHI; fire contained in 0.5 hours																	
FOBGF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01
FOFGF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	N/A	--
FOFHF	17	1.6E-14	1.6E+01	1.20E-15	1.6E+01	N/A	--	N/A	--	3.3E-15	1.6E+01	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01
FOFVF	17	N/A	--	N/A	--	N/A	--	1.00E-14	1.6E+01	N/A	--	N/A	--	8.0E-16	1.6E+01	N/A	--
FOSVF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01

See notes at end of table.

AD-A193 354 CHEMICAL STOCKPILE DISPOSAL PROGRAM RISK ANALYSIS OF THE ONSITE DISPOSAL O..(U) GA TECHNOLOGIES INC SAN DIEGO CA A W BARSELL ET AL. AUG 87 GA-C-18562 5/9

UNCLASSIFIED SAPEO-CDE-IS-87010 DAAA15-85-D-0022 F/G 15/6.3 NL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1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

TABLE 7-14 (Continued)

FLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F018 - Indirect large aircraft crash damages the MDB; no fire																	
FOBGS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FODHC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.5E-08	1.1E+01	4.0E-10	1.1E+01	N/A	--
FOCGC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--
FOCHC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.5E-08	1.1E+01	N/A	--	N/A	--
FOKGS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--
FOKHS	18	8.8E-09	1.1E+01	5.9E-10	1.1E+01	N/A	--	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOKVS	18	N/A	--	N/A	--	N/A	--	5.1E-09	1.1E+01	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--
FOMVC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOFGC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOPHC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	6.5E-08	1.1E+01	4.0E-10	1.1E+01	N/A	--
FOPVC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOQGC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOQVC	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FORGC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FORVC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
FOSVS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01
F019 - Indirect large aircraft crash damages the MDB; fire not contained in 0.5 hours																	
FOBGF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01
FODHC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-08	1.1E+01	3.3E-10	1.1E+01	N/A	--
FOCGC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--
FOCHC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-08	1.1E+01	N/A	--	N/A	--
FOKGF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--
FOKHF	19	7.1E-09	1.1E+01	4.8E-10	1.1E+01	N/A	--	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01
FOKVF	19	N/A	--	N/A	--	N/A	--	4.2E-09	1.1E+01	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--
FOMVC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
FOFGC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
FOPHC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	5.4E-08	1.1E+01	3.3E-10	1.1E+01	N/A	--
FOPVC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
FOQGC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F0QVC	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
F0RGC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
F0RVC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01
F0SVF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01
F020 - Indirect large aircraft crash damages the MDB; fire contained in 0.5 hours																	
F0BGF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01
F0FGF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	N/A	--
F0FHF	20	2.4E-12	1.4E+01	1.6E-13	1.4E+01	N/A	--	N/A	--	4.6E-13	1.4E+01	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01
F0RVF	20	N/A	--	N/A	--	N/A	--	1.4E-12	1.4E+01	N/A	--	N/A	--	1.1E-13	1.4E+01	N/A	--
F0SVF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01
F021 - Large or small direct aircraft crash damages the outdoor agent piping system at TEAD; no fire																	
F0AGS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--
F0AHS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--
F0AVS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--
F022 - Large or small direct aircraft crash damages the outdoor agent piping system at TEAD; fire occurs																	
F0AGS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.2E-09	1.0E+01	N/A	--
F0AHS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.2E-09	1.0E+01	N/A	--
F0AVS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.2E-09	1.0E+01	N/A	--

Notes:

1. Frequency unit = events/operating year
2. Scenarios 21 and 22 apply only to the TEAD bulk-only facility

TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
F025 - Earthquake damages the MDB structure, munitions fall & puncture; fire suppressed																	
F0BGC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.9E-07	7.2E+00	9.0E-09	6.6E+00
F0DHC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--
F0CGC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--
F0CHC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	N/A	--
F0KGC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-06	7.2E+00	N/A	--
F0KHC	25	7.1E-08	6.6E+00	2.1E-07	7.3E+00	N/A	--	N/A	--	7.1E-08	6.6E+00	N/A	--	1.6E-06	7.2E+00	7.1E-08	6.6E+00
F0KVC	25	N/A	--	N/A	--	N/A	--	9.9E-07	7.8E+00	N/A	--	N/A	--	1.6E-06	7.2E+00	N/A	--
F0MVC	25	2.3E-09	6.0E+00	N/A	--	N/A	--	N/A	--	2.3E-09	6.0E+00	N/A	--	5.0E-08	6.7E+00	2.3E-09	6.0E+00
F0FGC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
F0FHC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--	NEGL	--	N/A	--
F0FVC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--
F0QGC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--
F0QVC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
F0RGC	25	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	3.3E-07	6.7E+00	1.5E-08	6.0E+00
F0RVC	25	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	3.3E-07	6.7E+00	1.5E-08	6.0E+00
F0SVC	25	3.9E-07	6.6E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.4E-06	7.2E+00	3.9E-07	6.6E+00
F026 - Earthquake damages the MDB structure, munitions fall & puncture; earthquake initiates fire; fire suppression system fails.																	
F0BGC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.1E-09	1.3E+01	2.3E-10	1.1E+01
F0DHC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--
F0CGC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--
F0CHC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	N/A	--
F0KGC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.9E-08	1.3E+01	N/A	--
F0KHC	26	1.8E-09	1.1E+01	2.9E-08	1.5E+01	N/A	--	N/A	--	1.8E-09	1.1E+01	N/A	--	4.9E-08	1.3E+01	1.8E-09	1.1E+01
F0KVC	26	N/A	--	N/A	--	N/A	--	1.5E-07	1.6E+01	N/A	--	N/A	--	4.9E-08	1.3E+01	N/A	--
F0MVC	26	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--
F0FGC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
F0PHC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--
F0FVC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
F0QGC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A		NEGL	--	NEGL	--

See notes at end of table.

TABLE 7-14 (Continued)

FLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
FOQVC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--
FORGC	26	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	1.0E-08	1.4E+01	4.0E-10	1.0E+01
FORVC	26	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	1.0E-08	1.4E+01	4.0E-10	1.0E+01
FOSVC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-07	1.3E+01	9.9E-09	1.1E+01
FO29 - Earthquake damages the MDB; munitions are intact; fire occurs; fire suppression system fails.																	
FOBGC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FODHC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	2.2E-05	1.0E+01	N/A	--
FOLGC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--
FOCHC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--
FOFGC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--
FOFHC	29	7.8E-07	8.8E+00	2.3E-05	8.5E+00	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOFVC	29	N/A	--	N/A	--	N/A	--	1.2E-04	8.5E+00	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--
FOMVC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOPGC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOPHC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	7.8E-07	8.8E+00	2.2E-05	1.0E+01	N/A	--
FOPVC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOQGC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOQVC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FORGC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FORVC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FOSVC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00
FO33 - Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is intact; earthquake initiates fire; fire suppression system fails.																	
FOBGC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
FODHC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	4.8E-05	2.0E+01	N/A	--
FOLGC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	N/A	--
FOCHC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--
FOFGC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
FOFHC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
FOFVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
FOMVC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01

See notes at end of table.

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TABLE 7-14 (Continued)

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	AFG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
POFGC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
POFHC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	1.7E-06	2.0E+01	4.8E-05	2.0E+01	N/A	--
POFVC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
POGGC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
POGVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
PORGC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
PORVC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01
POSVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--

Notes:

1. Frequency unit = events/operating year

P016 - Indirect large aircraft crash onto the MHI; fire not contained in 0.5 h.

P017 - Indirect large aircraft crash onto the MHI; fire contained in 0.5 h.

P020 - Indirect large aircraft crash onto the MDB; fire contained in 0.5 h.

There is very little distinction in the frequency of aircraft crashes with or without fire since the historical data indicate that there is only a 45% probability that an aircraft crash will involve a fire. The frequency of a crash onto the MDB is greater than the MHI because the surface area of the MDB is more than 100 times larger than the MHI.

For the regional collocation option, it is evident that large aircraft crashes occur more frequently at ANAD than TEAD. The frequency of an aircraft crash onto the outdoor agent piping system for the modified CAMDS facility is a dominant risk contributor. This scenario includes both large and small aircraft crashes and the frequency of small aircraft crashes (including helicopters) is at least two orders of magnitude higher than the frequency of large aircraft crashes at TEAD.

7.2.5.4. Earthquake-Induced Accident Frequencies. Reference 7-5 contains the frequency and failure probability data for each event modeled in the event trees that served as input data for the analysis of the accident scenario frequencies. The results of the frequency analysis are presented in Table 7-14. The earthquake accident frequencies for the scenarios analyzed are generally higher at TEAD since it is located in a more earthquake-prone region. Sequence P033, which postulates an earthquake-initiated munition fall and fire but with the MDB and TOX intact, has the highest frequency value (1.7×10^{-6}/yr for ANAD and 4.8×10^{-5}/yr for TEAD). This scenario involves the

detonation of all munitions (if burstered) in the UPA since fire is not suppressed. The agent release results are discussed in Section 10.

7.2.5.5. Uncertainty Analysis. The results of the uncertainty analysis indicate that the 95% percentile values may be 7 to 20 times higher than the reported median values. The uncertainties arise mainly from the general applicability of the raw data used to the perceived conditions of environment of a demilitarization program.

7.3. REFERENCES

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8. SCENARIO LOGIC MODELS FOR TRANSPORT

This section describes the development of accident scenarios for onsite (truck) transport from the storage area to the disposal facility (MHI). The work was performed by H&R Technical Associates, Inc. The analysis covers only the actual transport; risks associated with loading, unloading, and other handling activities are considered as part of the handling phase in Section 6. Risks while the munitions are in storage awaiting transport are treated in Section 5.

Section 8.1 discusses logic models for accident scenarios during transport by truck. Note that the onsite transport scenarios are developed in terms of risk per mile.

8.1. ONSITE TRANSPORT

8.1.1. Chronology of Operations

Figure 3-1 shows a flow diagram of the handling and transport operations associated with the onsite disposal option. The munitions in ONCs are taken by truck from their storage locations to the disposal area Munitions Holding Igloo. Exceptions are noted for APG and NAAP, where the distance is so short that forklifts (handling phase) are used instead.

A set of 14 accident sequences involving collisions, overturns, fires, and external eveants was developed (Section 8.1.3). The sequences are designated as VO. Table 8-1 summarizes the sequences analyzed.

TABLE 8-1
SUMMARY OF TRUCK TRANSPORT ACCIDENT SEQUENCES

V01	A munitions vehicle collision/overturn occurs and crush forces fail the agent containment
V02	A munitions vehicle collision/overturn occurs and impact forces fail the agent containment
V03	A munitions vehicle collision/overturn occurs and puncture forces fail the agent containment
V04	Detonation of burstered munitions occurs by either (1) a fire-only accident, (2) an accident with mechanical force and fire, (3) a truck collision/overturn causing impact-induced rocket propellant ignition, or (4) a truck collision/overturn causing undue force detonation
V05	A munitions vehicle accident with fire occurs causing nonburstered munitions to fail
V06	An aircraft crashes on a munitions vehicle. No fire occurs; impact forces fail the agent containment
V07	An aircraft crashes on a munitions vehicle. Fire occurs, but impact fails agent containment
V08	Deleted due to scenario revisions
V09	A severe earthquake occurs, causing a munitions vehicle accident, and crush forces fail the agent containment
V010	A severe earthquake occurs, causing a munitions vehicle accident, and impact forces fail the agent containment
V011	A severe earthquake occurs, causing a munitions vehicle accident, and puncture forces fail the agent containment
V012	A severe earthquake occurs, causing a munitions vehicle accident, and fire detonates burstered munitions
V013	A severe earthquake occurs, causing a munitions vehicle accident, and fire fails nonburstered munitions
V014	A tornado occurs, generating a missile or causing a truck overturn, and mechanical forces fail agent containment
V015	An earthquake or tornado occurs, generating undue mechanical forces which cause detonation of burstered munitions.

8.1.2. Procedures and Assumptions

For this analysis it was assumed that all munitions will be placed inside cylindrical ONC packages with outer dimensions of approximately 8 ft long by 6 ft diameter (with failure thresholds as discussed in Section 3.3) prior to any movement. It was also assumed that a flatbed truck will be used as the transport vehicle. Each truck will carry four ONCs except spray tanks, which are trucked two at a time. Vehicle capacities for each munition are shown in Table 8-2.

A five-vehicle convoy will be used to transport munitions onsite. There is a lead security vehicle, one munition vehicle, a decontamination vehicle, an emergency vehicle, and a following security vehicle (Ref. 8-1). The small distance that the convoy travels, and the small number of trucks per convoy, make traffic control feasible to provide front, rear, and side collision protection. The major controls that affect the truck accident rate are:

1. No other movement activities or other activities which might pose a hazard to the munitions will be allowed to be carried out within 500 ft of the convoy route during munitions transport.

2. No fires external to the cargo will last longer than 10 min due to limits placed on the amount of truck fuel available.

3. Truck/train collisions are not credible because of the escort and the absence of train traffic during convoy movement.

4. No munitions movement will take place during periods of extreme weather conditions such as storms, tornado advisories, and blizzards, although a fully loaded truck may have to remain at rest during the bad weather.

TABLE 8-2
VEHICLE CAPACITIES FOR EACH MUNITION

Munition	Munitions Per Pallet	Pallets Per Package	Munitions Per Package	Packages Per Truck	Munitions Per Truck
M55 rocket	15	1	15	4	60
105-mm cartridge	24	1	24	4	96
105-mm projectile	24	1	24	4	96
155-mm cartridge	8	1	8	4	32
155-mm projectile	8	1	8	4	32
4.2-in. mortar	48	1	48	4	192
8-in. projectile	6	1	6	4	24
M23 land mine	36	1	36	4	144
MC-1 750-lb bomb	2	1	2	4	8
MK-94 500-lb bomb	2	1	2	4	8
Spray tank with overpack	1	NA	NA	2	2
Ton container	1	1	1	4	4

Using this convoy model, several general assumptions can be made about the types of accidents that are possible:

1. Head-on collisions with a munitions vehicle are not credible.

2. Collisions in which a munitions vehicle rear-ends another vehicle are low-speed events limited by convoy speed.

3. Collisions in which a munitions vehicle hits a stationary object or overturns are low-speed events limited by convoy speed.

4. Collisions in which a munitions vehicle is rear-ended by another vehicle are low-speed events limited by convoy speed.

5. Collisions in which a munitions vehicle is struck from the side are not credible because of restrictions on other movement activities during convoy movement.

These assumptions limit the type of accident scenarios envisioned for local munition transport to truck collisions and overturns, spontaneous fires, and nonpreventable external events such as aircraft crashes, earthquakes, and tornadoes during transport.

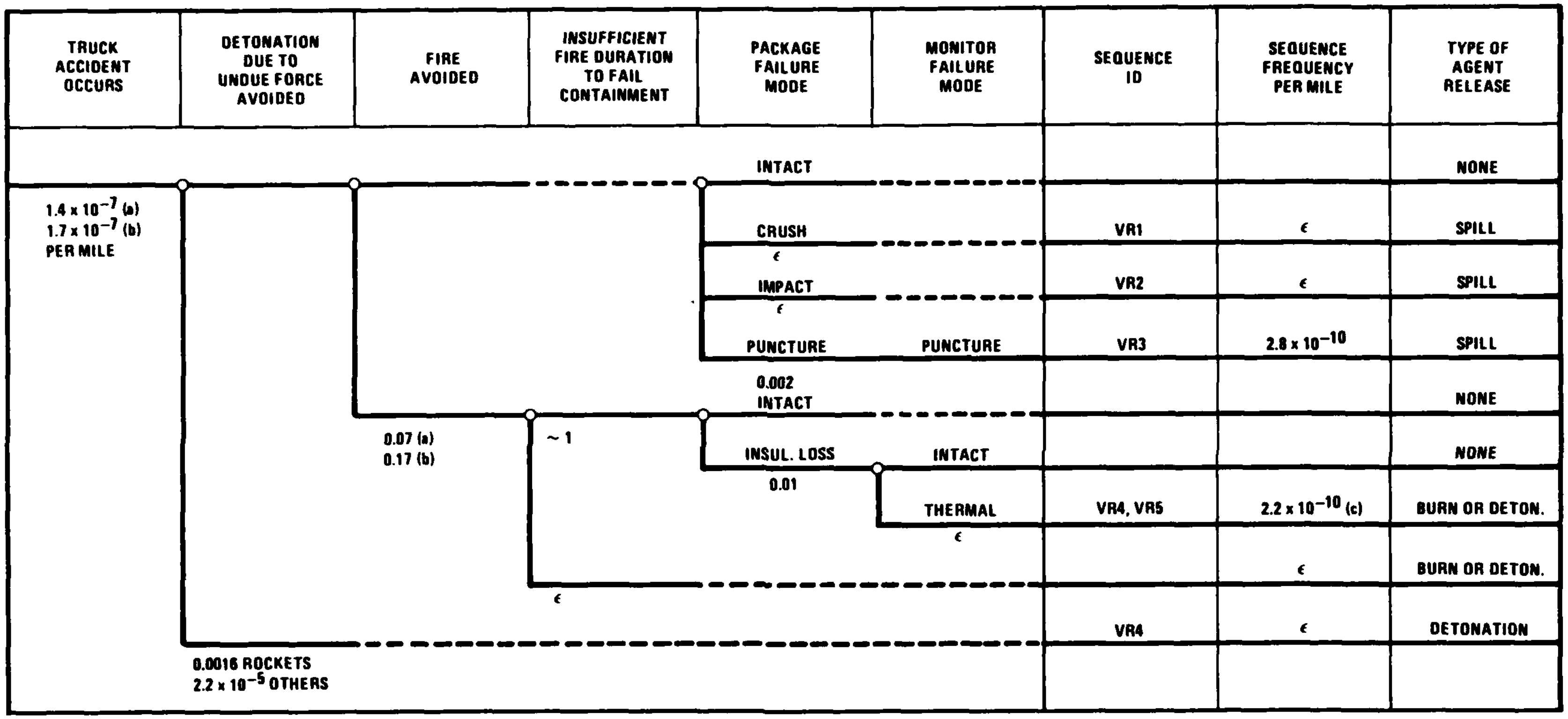
8.1.3. Accident Scenario Analysis

Section 4.1 describes the logic for initiating event selection of onsite transport accidents. Table 4-4 shows four families of initiating events: (1) truck collision or overturn accident due to human error or equipment failure, (2) aircraft crash into the truck, (3) earthquake-induced collision or overturn, and (4) tornado-caused collision/overturn or missile impact. These four IE families were used to develop the scenario event trees as described in the subsections below.

8.1.3.1. Truck Collision/Overturn. Figure 8-1 shows the event tree for truck collision or overturn due to human error or mechanical failure. There are five important sequences (V01 through V05) resulting from this scenario, differentiated by the types of force that could cause agent release (crush, impact, puncture, and fire). These are sequences V01 through V05 (Table 8-1).

Data base information (Refs. 8-1 through 8-5) regarding the initiating event frequency is described in Section 9.2. For generic highway accidents that rate is 2.5×10^{-6} collisions/overturns per mile. However, this rate is modified for the use of convoy and administrative controls (Table 9-1). The convoy speed will be selected so that the maximum velocity at which a collision or rollover involving a munitions vehicle can occur in convoy conditions is estimated to be no greater than 30 mph, even assuming gross driver error or mechanical failure (e.g., brakes) on a hill. Because the convoy is moving at low speed relative to highway traffic and under closely controlled conditions, the time allowed for driver response to threatening conditions is much greater at the lower speed, and collision-type accidents and overturn-type accidents are more avoidable. Convoy accident frequencies have been decreased by a factor of 10 from highway accident frequencies because of greater driver awareness and control during convoy conditions. The probability of accidental collisions and overturns involving mechanical forces thus becomes 1.4×10^{-7} per mile. Mechanical force accident scenarios represent 83% of the total accidents expected.

Fires can break out in the cargo and in the vehicle without the occurrence of a mechanical force accident. The SNL standard highway frequency for this type of accident is 2.8×10^{-8} per mile. The use of convoy controls does not change the probability of a fire occurring, so the accident rate used for convoy traffic is unchanged. Fire-only scenarios represent 17% of the total accidents expected.



(a) COLLISION/OVERTURN
(b) ALL TRUCK ACCIDENTS
(c) ROCKETS ONLY, ϵ FOR OTHER MUNITIONS

Fig. 8-1. Event tree for onsite transportation (truck accident)

The probabilities of mechanical forces (crush, impact, and puncture) being generated in a truck accident were taken from Ref. 8-2. These values are consistent with the data in Ref. 8-3. The probability of an undue mechanical force causing burster detonation was derived from the truck velocity data in Ref. 8-1, assuming a log normal distribution with a 50% probability of detonation at 123 mph and a 10^{-6} probability at 135 mph (Ref. 8-6).

The probabilities of the top events of the event tree in Fig. 8-1 are discussed in Tables 8-3 through 8-7 for the munitions in ONCs.

8.1.3.2. Aircraft Crash. Figure 8-2 shows the event tree for aircraft crash into a truck. The initiating event frequency is discussed and quantified in Section 4.2 in terms of number of crashes of small and large aircraft per year at each site (Table 4-6). Aircraft crash values from Table 4-6 were multiplied by a factor of 0.313 to account for uncontrolled crashes. An uncontrolled crash is defined as one where the impact angle is greater than 10 deg. It was assumed that for an aircraft to actually hit a truck, the crash would have to be uncontrolled. An inherent assumption is that an accident involving an aircraft crashing onto a munitions vehicle more closely resembles the Sandia National Laboratory (SNL) model of a typical aircraft crash rather than the SNL model of a typical truck crash. In a typical SNL aircraft crash, the crush and puncture forces are negligible compared to the impact forces. Further details are available in Ref. 8-1.

There are two important accident sequences resulting from the aircraft crash event tree, V06 and V07. These are described and quantified in Tables 8-8 and 8-9.

8.1.3.3. Earthquake. Figure 8-3 shows the event tree for the earthquake occurrence impact on onsite transport. Section 4.2 presents earthquake frequencies as a function of earthquake intensity and site. In this study, an earthquake intensity of 0.5 g is assumed to be needed

TABLE 8-3
ONSITE TRANSPORT SEQUENCE 1

V01 - A truck collision/overturn occurs in which the munitions are subjected primarily to crush forces with other forces being negligible. The agent release frequency is the product of three basic events: BE31, BE68, and BE73.

Event No.	Name	Probability	Reference/Remarks
BE31	Truck collision/ overturn	1.4×10^{-7} per mile	Table 9-1
BE68	Crush force generated	1.0	Reference 8-2
BE73	Crush force fails agent containment	0.1	The crush failue threshold of each munition is greater than 50,000 lb, therefore this is a conservative value for failure of agent containment.

Thirteen percent of the time, the release is an agent spill only; however, 7% of the time fire is also present, resulting in some unburned vapor release to the atmosphere.

TABLE 8-4
ONSITE TRANSPORT SEQUENCE 2

V02 - A truck collision/overturn occurs in which munitions are subjected primarily to impact forces with other forces being negligible. The agent release frequency is the product of three basic events: BE31, BE60, and BE71.

Event No.	Name	Probability	Reference/Remarks
BE31	Truck collision/ overturn	1.4×10^{-7} per mile	Table 9-1
BE60	Impact force generated	1.0	Reference 8-2
BE71	Impact force fails agent containment (>35 mph)	ϵ	The impact failure threshold for the package is 35 mph. The maximum postulated impact velocity in any accident is 30 mph, thereafter, the probability of agent release due to impact to zero, or very close to it, signified by epsilon (ϵ).

TABLE 8-5
ONSITE TRANSPORT SEQUENCE 3

V03 - A truck collision/overturn occurs in which the munitions are subjected primarily to puncture forces with other forces being negligible. The agent release frequency is the product of three basic events: BE31, BE64, and BE67.

Event No.	Name	Probability	Reference/Remarks
BE31	Truck collision/ overturn	1.4×10^{-7} per mile	Table 9-1
BE64	Puncture environment occurs	1.64×10^{-2}	Reference 8-2
BE67	Probe fails agent containment	2.4×10^{-2}	Reference 8-2

93% of the time the consequence is an agent spill only; however, 7% of the time fire is also present, resulting in some unburned vapor release to the atmosphere.

TABLE 8-6
ONSITE TRANSPORT SEQUENCE 4

V04 - Detonation of burstered munitions by (1) fire-only accident, (2) mechanical force and fire, (3) truck collision/overturn impact-induced rocket propellant ignition, or (4) truck collision/overturn induced undue force detonation. The release frequency is calculated by: (BE31) (BE62) (BE63) + (BE31A) (BE52′) (BE62A) (BE63) + (BE31A) (BE60) (BE61R) + (BE31A) (BE61). The third term is for rockets only.

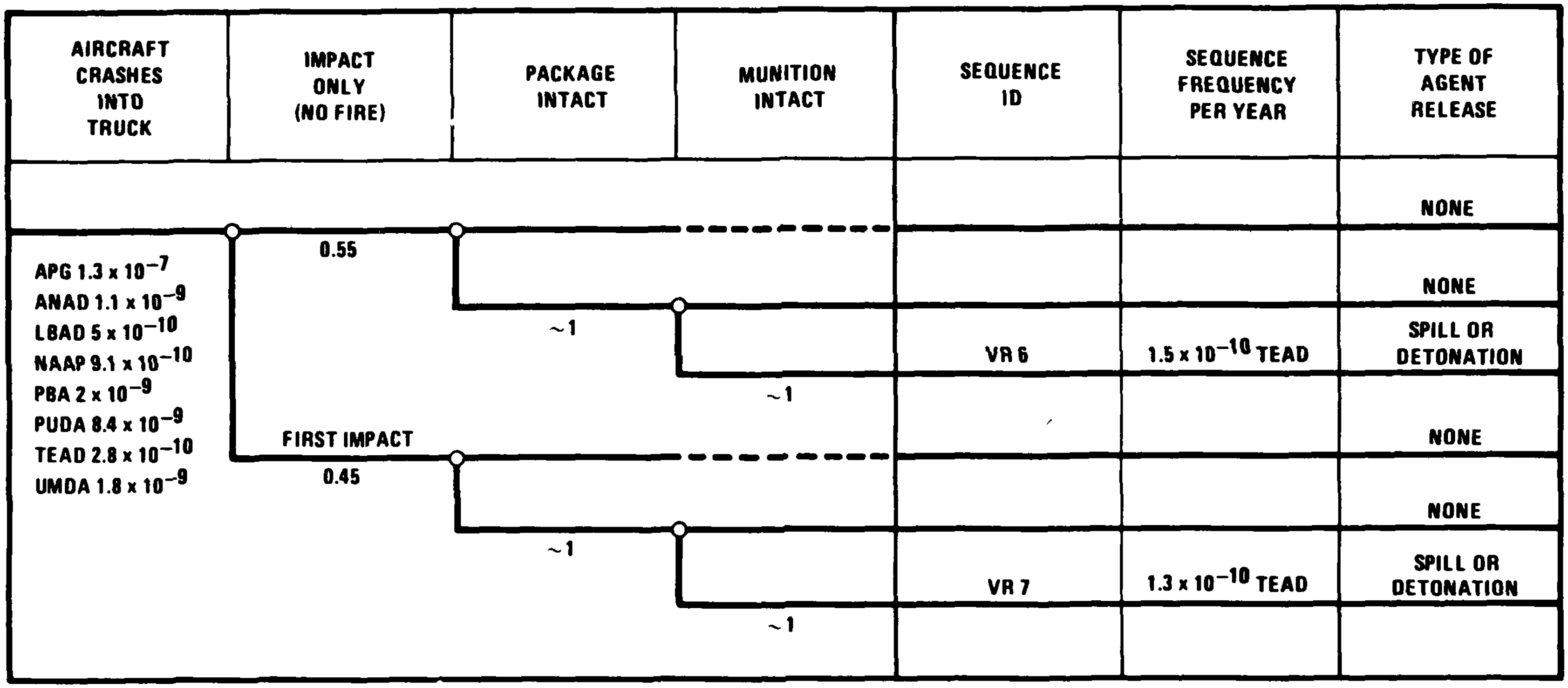
Event No.	Name	Probability	Reference/Remarks
BE31	Truck accident occurs	1.7×10^{-7} per mile	Table 9-1
BE62	Fire generated	0.17	Table 9-1
BE63	Fire has heat and duration to detonate burster (>15 min)	10^{-6}	Trucks limited to only enough fuel for the fire to last 10 min.
BE31A	Truck collision/ overturn occurs	1.4×10^{-7} per mile	Table 9-1
BE52′	Mechanical forces destroy package insulation	1×10^{-2}	Reference 8-6
BE62A	Fire occurs, given a collision or overturn	0.07	Reference 8-6
BE60	Impact force generated	1.0	Reference 8-1
BE61(R)	Impact force sufficient to detonate burster	0.002	Reference 8-5
BE61	Undue force detonation occurs	2.2×10^{-5}	Reference 8-6

Puncture-induced rocket propellant ignition has not been included because there is no evidence that a probe exists or could occur at the velocities necessary to cause puncture-induced propellant ignition. A 30-caliber bullet traveling about 1500 mph is required.

TABLE 8-7
ONSITE TRANSPORT SEQUENCE 5

V05 - A truck accident occurs and a resulting fire fails non-burstered munitions. The agent release frequency is the product of three basic events: BE31, BE62, and BE75, added to the product of BE31A, BE52′, BE62A, and BE75.

Event No.	Name	Probability	Reference/Remarks
BE31	Truck accident occurs	1.7×10^{-7} per mile	Table 9-1
BE62	Fire occurs	0.17	Table 9-1
BE75	Thermal force fails agent containment (>15 min)	10^{-6}	Trucks are limited to carrying only enough fuel for a 10-min fire.
BE31A	Truck collision/ overturn occurs	1.4×10^{-7} per mile	Table 9-1
BE52′	Mechanical forces destroy package insulation	1×10^{-2}	Reference 8-6
BE62A	Fire, given a collision	0.07	Reference 8-6



NOTE: INITIATING EVENT AND SEQUENCE FREQUENCIES ARE IN UNITS OF PER EXPOSURE YEAR.

Fig. 8-2. Event tree for onsite transportation (aircraft crash)

TABLE 8-8
ONSITE TRANSPORT SEQUENCE 6

V06 - An aircraft crashes into a munitions truck; no fire results. In aircraft accidents, the SNL data indicate that the predominant mechanical force employed against cargo packages is impact, with crush and puncture having negligible effect. The agent release frequency is the product of three impact basic events: BE31, BE60, and BE71.

Event No.	Name	Probability	Reference/Remarks
BE31	Aircraft crash		
	APG	1.3×10^{-7}	Nine percent of all crashes are on takeoff, 32% inflight, and 58% on landing. Fifteen percent have impact angles greater than 10 deg in takeoff crashes, 70% in midflight crashes, and 13% in landing crashes (Refs. 8-6 and 8-7).
	ANAD	1.1×10^{-9}	
	LBAD	5×10^{-10}	
	NAAP	9.1×10^{-10}	
	PBA	2×10^{-9}	
	PUDA	8.4×10^{-9}	
	TEAD	2.8×10^{-10}	
	UMDA	1.8×10^{-9}	
BE60	Impact force only generated (no fire)	0.55	Derived from data in Ref. 8-1; 49% of all aircraft crashes involve impact with or without other forces; 27% of them are impact only; 0.27/0.49 = 0.55.
BE71	Impact force fails agent containment	1	Conservatively assumes that at least one package fails every time. Burstered munitions will detonate; nonburstered munitions fail.

TABLE 8-9
ONSITE TRANSPORT SEQUENCE 7

V07 - An aircraft crashes onto a munition truck, fire occurs but impact forces fail agent containment. The agent release frequency is the product of three basic events: BE31, BE60/62, and BE71.

Event No.	Name	Probability	Reference/Remarks
BE31	Aircraft crash		
	APG	1.3×10^{-7}	See remarks, sequence 6.
	ANAD	1.1×10^{-9}	
	LBAD	5×10^{-10}	
	NAAP	9.1×10^{-10}	
	PBA	2×10^{-9}	
	PUDA	8.4×10^{-9}	
	TEAD	2.8×10^{-10}	
	UMDA	1.8×10^{-9}	
BE60/62	Impact and fire generated	0.45	0.22/0.49 = 0.45 (fire and impact/all impact).
BE71	Impact force fails agent containment	1	Conservatively assumes that at least one package fails every time. Burstered munitions detonate. Nonburstered munitions release agent by spill and vapor.

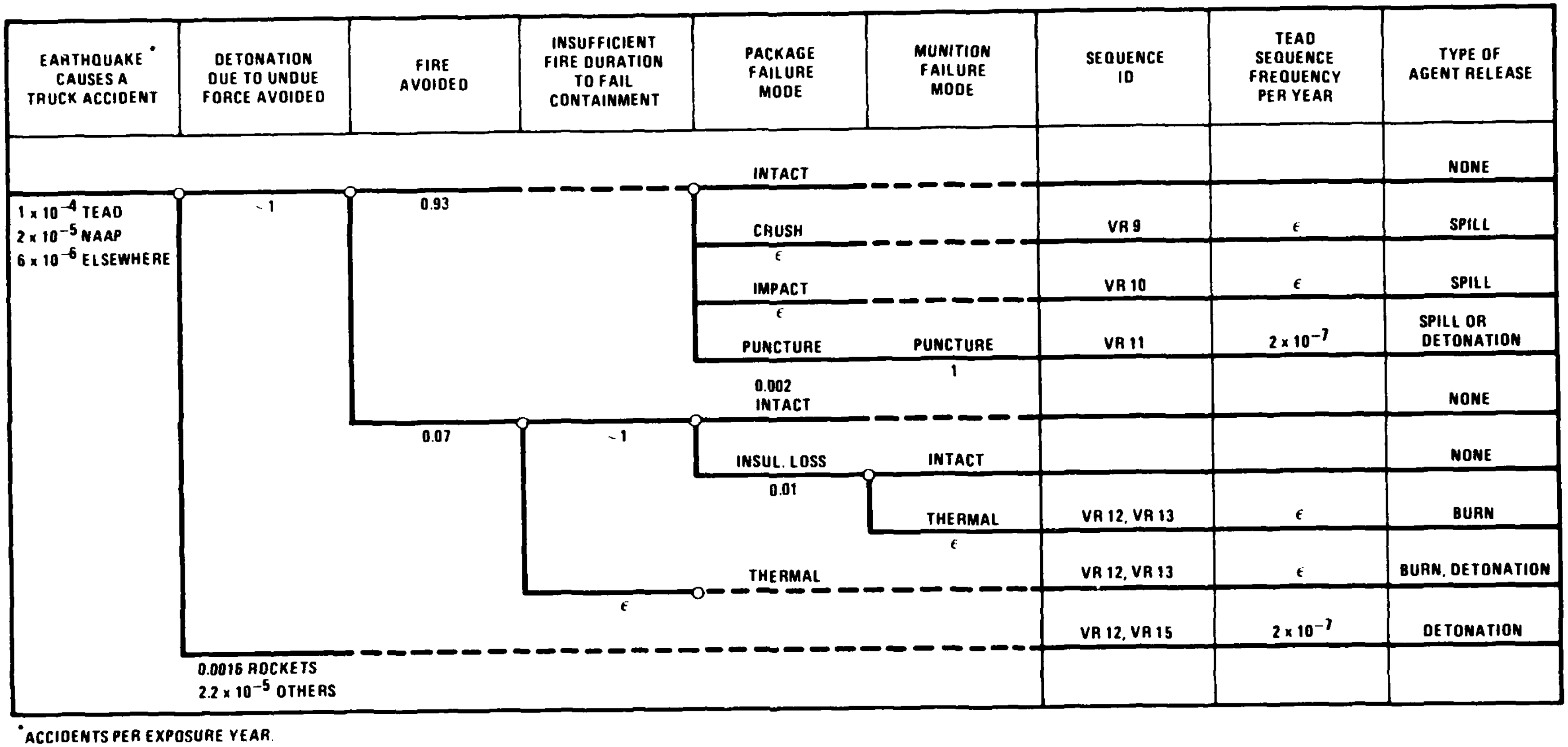


Fig. 8-3. Event tree for onsite transportation (earthquake)

to cause a truck collision or overturn. Thus, the initiating event frequency is taken to that for a 0.5 g earthquake or greater (called a "severe earthquake") at the specific site.

The following sequences resulted from the earthquake event tree analysis:

V09 - A severe earthquake occurs, causing a munitions vehicle accident, and crash forces fail the agent containment.

V010 - A severe earthquake occurs, causing a munitions vehicle accident, and impact forces fail the agent containment.

V011 - A severe earthquake occurs, causing a munitions vehicle accident, and puncture forces fail the agent containment.

V012 - A severe earthquake occurs, causing a munitions vehicle accident, and fire detonates burstered munitions.

V013 - A severe earthquake occurs, causing a munitions vehicle accident, and fire fails nonburstered munitions.

V015 - An earthquake or tornado occurs, generating undue mechanical forces which cause detonation of burstered munitions.

Note that V015 has a dual initiator, either a severe earthquake or a tornado (analyzed in the next subsection). Quantification of the earthquake event tree analysis is shown in Tables 8-10 through 8-15.

8.1.3.4. <u>Tornado</u>. Figures 8-4 and 8-5 show the event trees for a tornado or high winds causing a truck collision overturn or generating an impacting missile. The tornado frequency is presented in Section 4.2 for the specific sites. Quantification of the event trees is summarized in Table 8-16.

TABLE 8-10
ONSITE TRANSPORT SEQUENCE 9

V09 - An earthquake occurs in which the munitions are subjected primarily to crush forces with other forces being negligible. The agent release frequency is the product of three basic events: BE31, BE68, and BE73.

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	Table 4-6; a ≥0.5-g earthquake is assumed. See external events section.
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE68	Crush force generated	1.0	Reference 8-2
BE73	Crush force fails agent containment	0.1	Same as sequence 1.

TABLE 8-11
ONSITE TRANSPORT SEQUENCE 10

V010 - An earthquake occurs in which the munitions are subjected primarily to impact forces with other forces being negligible. The accident release frequency is the product of three basic events: BE31, BE60, and BE71.

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	Table 4-6; assumes ≥0.5-g earthquake.
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE60	Impact force generated	1.0	Reference 8-2
BE71	Impact force fails agent containment	ϵ	Same as sequence 2.

TABLE 8-12
ONSITE TRANSPORT SEQUENCE 11

V011 - An earthquake occurs in which the munitions are subjected primarily to puncture forces with other forces being negligible. The agent release frequency is the product of three basic events: BE31, BE64, and BE67.

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	Table 4-6
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE64	Puncture environment occurs	0.0164	Reference 8-2
BE67	Probe fails agent containment	0.024	Reference 8-2

TABLE 8-13
ONSITE TRANSPORT SEQUENCE 12

VO12 - An earthquake occurs and accidental forces cause detonation of burstered munitions. This scenario is similar to scenario VO4. The agent release frequency is the product of three basic events: BE31, BE62, and BE63 added to the product of BE31, BE52′, BE62, and BE63. The product of three propellant-ignition events: BE31, BE60, and BE61R is added to the result for rockets.[a]

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	Table 4-6
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE62	Fire generated	0.07	Reference 8-6
BE63	Fire has heat and duration to detonate burster (>15 min)	10^{-6}	Trucks are limited to only enough fuel for a 10-min fire.
BE52′	Mechanical forces destroy package insulation	1×10^{-2}	Reference 8-6
BE60	Impact force generated	1.0	Reference 8-2
BE61(R)	Impact force sufficient to detonate burster by prepellant ignition (rockets only)	0.002	Reference 8-5

[a]Puncture-induced rocket propellant ignition has not been included because there is no evidence that a probe exists or could occur at velocities necessary to cause propellant ignition (30-caliber bullets traveling about 1500 mph are required).

TABLE 8-14
ONSITE TRANSPORT SEQUENCE 13

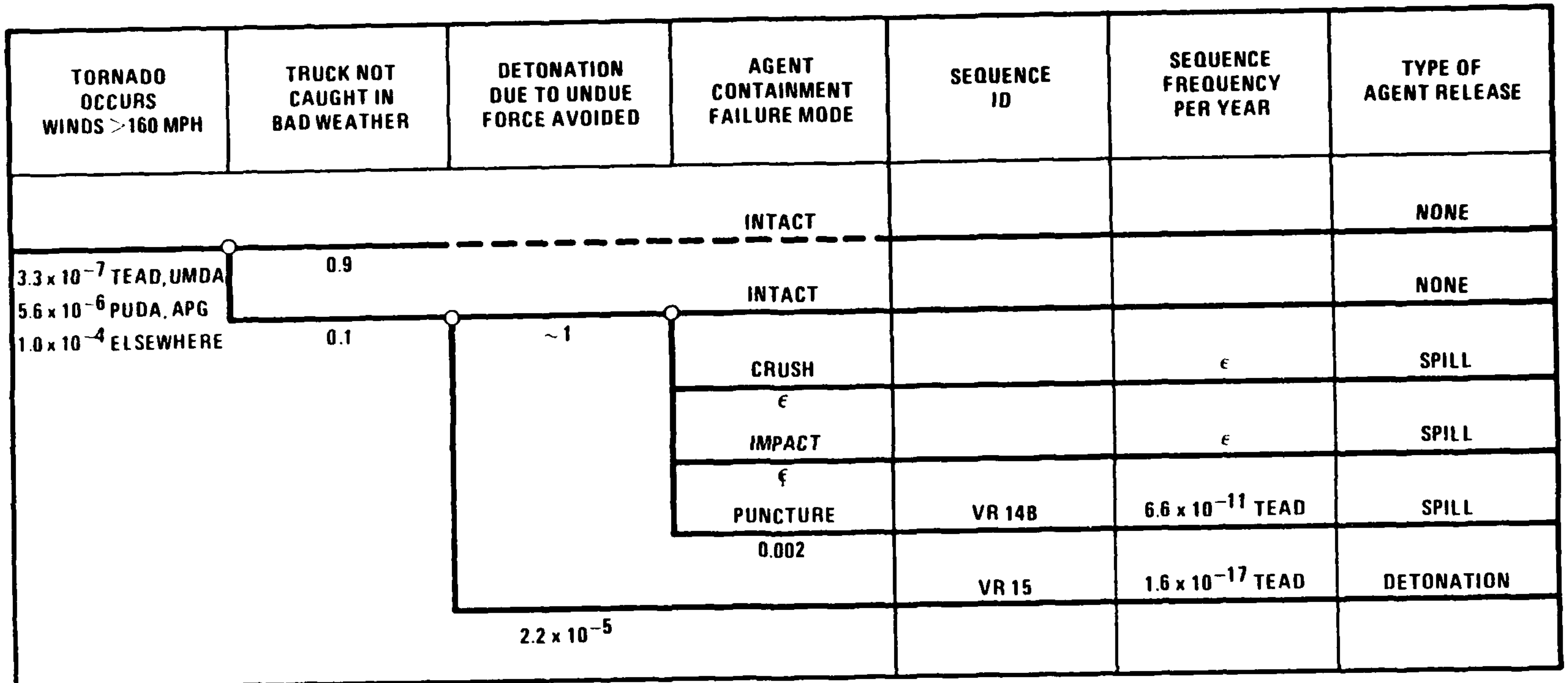
V013 - An earthquake occurs and fire fails nonburstered munitions. The agent release frequency is the product of three external fire basic events: BE31, BE62, and BE75 added to the product of BE31, BE52′, BE62, BE75.

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	Table 4-6
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE62	Fire generated	0.07	Reference 8-6
BE75	Thermal force fails agent containment (>15 min)	10^{-6}	Trucks are limited to only enough fuel for a 10-min fire.
BE52′	Mechanical forces destroy package insulation	1×10^{-2}	Reference 8-6

TABLE 8-15
ONSITE TRANSPORT SEQUENCE 15

V015 - An earthquake or tornado occurs, generating undue mechanical forces which cause detonation of burstered munitions (C, P, M, R) (BE31) (BE61) + (BE31A) (BE31A′) (BE61).

Event No.	Name	Probability	Reference/Remarks
BE31	Earthquake occurs		
	TEAD	1×10^{-4}	See Section 4.2.
	NAAP	2×10^{-5}	
	Elsewhere	6×10^{-6}	
BE31A	Tornado occurs		
	TEAD, UMDA	3.3×10^{-7}	See Section 4.2.
	PUDA, APG	5.6×10^{-6}	
	Elsewhere	1.0×10^{-4}	
BE31A′	Trucks traveling in bad weather	1×10^{-1}	Assumes a 10% probability that the administrative control prohibiting travel during bad weather is violated.
BE61	Undue mechanical force sufficient to detonate burster occurs	2.2×10^{-5}	Reference 8-6



NOTE: INITIATING EVENT AND SEQUENCE FREQUENCIES ARE PER EXPOSURE YEAR.

Fig. 8-4. Event tree for tornado-caused collision/overturn during onsite transportation

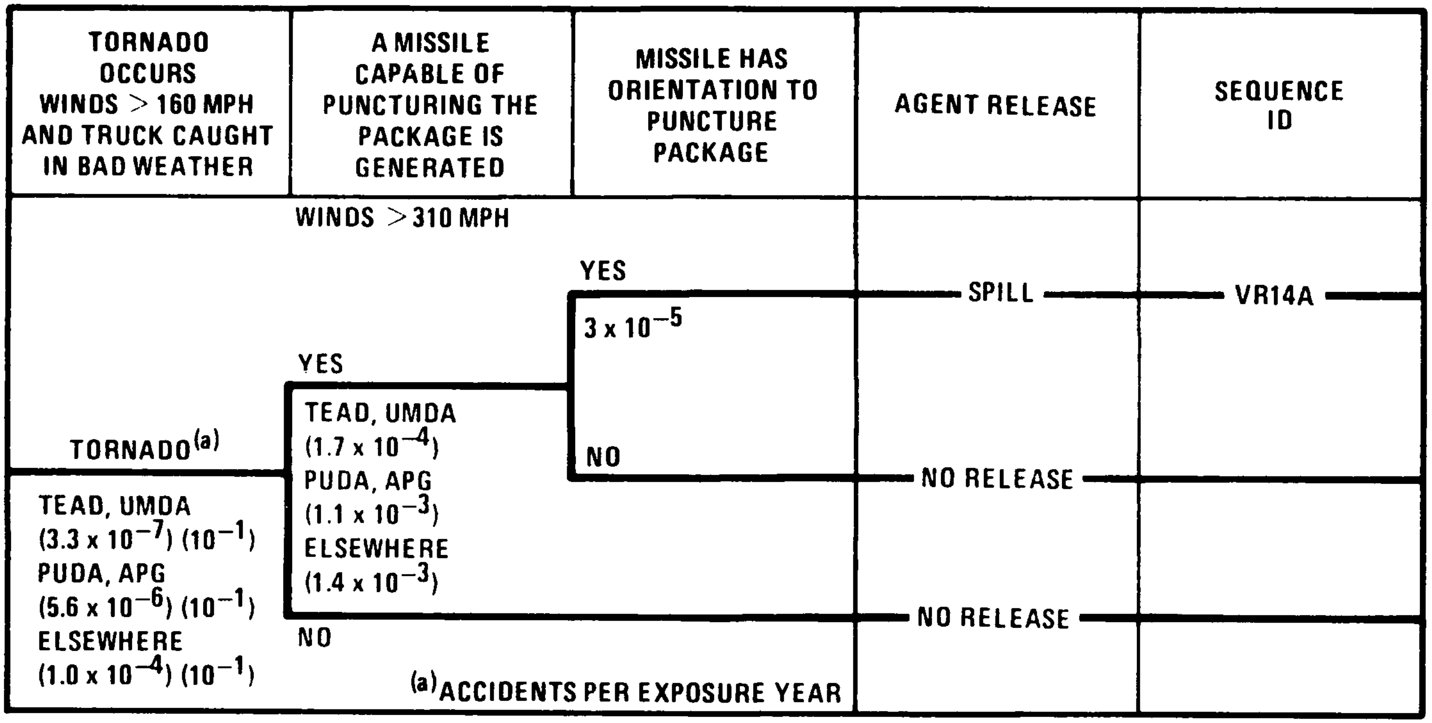


Fig. 8-5. Event tree for tornado-generated missile affecting onsite transportation

TABLE 8-16
ONSITE TRANSPORT SEQUENCE 14

V014 - A tornado occurs, either generating a missile or causing truck overturn. This scenario is discussed in two parts: 14A and 14B. 014A is the tornado-generated missile scenario and the release frequency is the product of events BE31, BE31′, BE64, and BE51. 14B is the mechanical forces cause agent release and is the result of the calculation (BE31) (BE31′) (BE68) (BE53) + (BE31) (BE31′) (BE60) (BE52) + (BE31) (BE31′) (BE64A) (BE51A).

V014A - Tornado-generated missile causes agent containment to fail.

Event No.	Name	Probability	Reference/Remarks
BE31	Tornado occurs (winds >160 mph)		Site specific; see Section 4.2.
	TEAD, UMDA	3.3×10^{-7}	
	PUDA, APG	5.6×10^{-6}	
	Elsewhere	1.0×10^{-4}	
BE31′	Truck traveling in bad weather	1×10^{-1}	Assumes a 10% chance that the administrative control prohibiting travel in bad weather will be violated.
BE64	Tornado-generated missile capable of puncturing and failing agent containment occurs (winds >250 mph)		Fraction of winds >160 mph that are also >250 mph. See external events section and Appendix C. Conservative for heavy-walled munitions.
	TEAD, UMDA	5.4×10^{-3}	
	PUDA, APG	1.8×10^{-2}	
	Elsewhere	1.4×10^{-2}	
BE51	Missile fails agent containment	5.3×10^{-5}	Methodology in Appendix C.

TABLE 8-16 (Continued)

V014B - Tornado causes a truck collision/overturn, generating mechanical forces that fail agent containment.[a]

Event No.	Name	Probability	Reference/Remarks
BE31	Tornado occurs (winds >160 mph) TEAD, UMDA PUDA, APG Elsewhere	 3.3×10^{-7} 5.6×10^{-6} 1.0×10^{-4}	See external events section.
BE31′	Truck traveling in bad weather	1×10^{-1}	Assumes a 10% chance that the administrative control prohibiting travel during bad weather is violated.
BE68	Crush force generated	1.0	Reference 8-2
BE60	Impact force generated	1.0	Reference 8-2
BE64A	Puncture environment	0.0164	Reference 8-2 occurs.
BE53	Crush fails agent containment	0.1	Same as sequence V09.
BE52	Impact fails containment (>35 mph)	ϵ	Maximum postulated velocity change (30 mph) does not exceed package failure threshold of 35 mph.
BE51A	Probe fails agent containment (0.75 in. mild steel wall equivalent thickness)	0.024	Reference 8-1

[a] It is assumed that, given the high winds present during a tornado, and the high probability of accompanying rain, that a significant fire will not be initiated by the tornado, or sustained during the tornado.

8.1.4. Agent Release

The calculation models described in Section 10 were used to determine the agent released for the onsite transportation accident sequences. The agent release results for these accident sequences are also given in Section 10.

8.1.5. Analytical Results

The results of the probabilistic analysis of the accident sequences (median frequency values) are shown in Table 8-17, including the results of the uncertainty analysis of the agent release sequence frequency values. The range factor is the ratio of the 95th percentile value to the 50th percentile value of a log normal distribution. The accident frequencies for sequences 1 to 5 are reported per truck mile. The accident frequencies for sequences 6 to 15 are reported per exposure year. No quantitative screening of the scenarios was done at this point in the analysis because the accidents per mile need to be multiplied by the number of miles (a classified number) prior to a meaningful screening analysis.

The number of munitions truckloads is computed from the classified stockpile values divided by the number of munitions per truck load from Table 8-2. The accident frequency is determined by first multiplying the values in Table 8-3 by the number of truckloads. This product is multiplied either by the number of onsite truck miles or by the number of onsite truck exposure years. It is assumed that the trucks move individually to and from the railhead at an effective speed of 10 mph. The total exposure time is the onsite distance divided by 10 mph.

The final results of the accident scenario analysis (per munition inventory) are contained in a classified appendix to this report.

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TABLE 8-17
ONSITE TRANSPORTATION - ONSITE DISPOSAL OPTION
(Movement from Storage to Demil Facility in Onsite Package)

Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VOBGS	1	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VODHS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--
VOCGS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--
VOCHS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--
VOKGS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--
VOKHS	1	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOKVS	1	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--
VOMVS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOPGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOPHS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--
VOPVS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOQGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOQVS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VORGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VORVS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOSVS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01
VOWGS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--
VOBGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VODHS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--
VOCGS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--
VOCHS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--
VOKGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--
VOKHS	3	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOKVS	3	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--
VOMVS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOPGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOPHS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--
VOPVS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOQGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01

See notes at end of table.

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TABLE 8-17 (Continued)

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)
Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VOQVS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VORGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VORVS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOSVS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01
VOWGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--
VODHC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	N/A	--
VOCGC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--
VOCHC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--
VOMVC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02
VOPGC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02
VOPHC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	N/A	--
VOPVC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02
VOQGC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02
VOQVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02
VORGC	4	2.8E-10	3.3E+01	N/A	--	2.8E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	2.8E-10	3.3E+01
VORVC	4	2.8E-10	3.3E+01	N/A	--	2.8E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	2.8E-10	3.3E+01
VORGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02
VOKGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--
VOKHF	5	2.8E-14	1.6E+02	2.8E-14	1.6E+02	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02
VOKVF	5	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--
VOSVF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02
VOWGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--
VORGS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VODHC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-09	2.0E+01	1.6E-10	2.0E+01	N/A	--
VOCGC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--
VOCHC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-09	2.0E+01	N/A	--	N/A	--
VOKGS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--
VOKHS	6	6.0E-10	2.0E+01	7.2E-08	2.0E+01	N/A	--	N/A	--	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOKVS	6	N/A	--	N/A	--	N/A	--	5.0E-10	2.0E+01	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--

See notes at end of table.

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TABLE 8-17 (Continued)

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)
Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR
VOMVC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--
VOFGC	6	6.0E-10	2.0E+01	N/A	--	N/A		N/A	--
VOPHC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--
VOPVC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--
VOQGC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--
VOQVC	6	N/A	--	N/A	--	N/A	--	N/A	--
VORGC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--
VORVC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--
VOSVS	6	N/A	--	N/A	--	N/A	--	N/A	--
VOWGS	6	N/A	--	N/A	--	N/A	--	N/A	--
VOBGF	7	N/A	--	N/A	--	N/A	--	N/A	--
VODHC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--
VOCGC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--
VOCHC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--
VOKGF	7	N/A	--	N/A	--	N/A	--	N/A	--
VOKHF	7	4.9E-10	2.0E+01	5.9E-08	2.0E+01	N/A	--	N/A	--
VOKVF	7	N/A	--	N/A	--	N/A	--	4.1E-10	2.0E+01
VOMVC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--
VOFGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VOPHC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VOPVC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VOQGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VOQVC	7	N/A	--	N/A	--	N/A	--	N/A	--
VORGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VORVC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--
VOSVF	7	N/A	--	N/A	--	N/A	--	N/A	--
VOWGF	7	N/A	--	N/A	--	N/A	--	N/A	--
VOBGS	9	N/A	--	N/A	--	N/A	--	N/A	--
VODHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--

SCEN-ARIO	No.	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VOMVC	6	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOFGC	6	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOPHC	6	N/A	--	4.7E-08	2.0E+01	1.6E-10	2.0E+01	N/A	--
VOPVC	6	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOQGC	6	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOQVC	6	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VORGC	6	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VORVC	6	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOSVS	6	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01
VOWGS	6	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--
VOBGF	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VODHC	7	N/A	--	3.9E-09	2.0E+01	1.3E-10	2.0E+01	N/A	--
VOCGC	7	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--
VOCHC	7	N/A	--	3.9E-09	2.0E+01	N/A	--	N/A	--
VOKGF	7	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--
VOKHF	7	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOKVF	7	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--
VOMVC	7	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOFGC	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOPHC	7	N/A	--	3.9E-09	2.0E+01	1.3E-10	2.0E+01	N/A	--
VOPVC	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOQGC	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOQVC	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VORGC	7	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VORVC	7	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOSVF	7	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01
VOWGF	7	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--
VOBGS	9	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VODHS	9	N/A	--	6.0E-07	1.1E+01	1.0E-05	1.1E+01	N/A	--

See notes at end of table.

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TABLE 8-17 (Continued)

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)
Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VOCGS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	--	N/A	--
VOCHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	1.1E+01	N/A	--
VOKGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--
VOKHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOKVS	9	N/A	--	N/A	--	N/A	--	2.0E-06	1.1E+01	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--
VOMVS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOFGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOFHS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	6.0E-07	1.1E+01	1.0E-05	1.1E+01	N/A	--
VOFVS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOQGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOQVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VORGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VORVS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOSVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01
VOWGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--
VOBGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VODHS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	3.9E-08	1.4E+01	N/A	--
VOCGS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--
VOCHS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--
VOKGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--
VOKHS	11	2.4E-09	1.4E+01	2.4E-09	1.4E+01	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOKVS	11	N/A	--	N/A	--	N/A	--	7.9E-09	1.4E+01	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--
VOMVS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOFGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOPHS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	2.4E-09	1.4E+01	3.9E-08	1.4E+01	N/A	--
VOFVS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOQGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOQVS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VORGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01

See notes at end of table.

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TABLE 8-17 (Continued)

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)
Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VORVS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOSVS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01
VOWGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--
VODHC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	7.1E-12	8.8E+01	N/A	--
VOCGC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	N/A	--
VOCHC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--
VOMVC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02
VOFGC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02
VOPHC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	4.2E-13	1.0E+02	7.1E-12	8.8E+01	N/A	--
VOFVC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02
VCCGC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02
VOOVC	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02
VORGC	12	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	2.0E-07	2.0E+01	1.2E-08	1.7E+01
VORVC	12	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	2.0E-07	2.0E+01	1.2E-08	1.7E+01
VOPGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02
VOKGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--
VOLHC	13	4.2E-13	1.1E+02	4.2E-13	1.1E+02	N/A	--	N/A	--	4.2E-13	1.1E+02	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02
VOKVC	13	N/A	--	N/A	--	N/A	--	1.4E-12	1.2E+02	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--
VOSVC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02
VOWGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--
VOBGC	14	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VODHC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-08	1.2E+01	3.3E-09	1.3E+01	N/A	--
VOCGC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--
VOCHC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-08	1.2E+01	N/A	--	N/A	--
VOKGS	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--
VOKHS	14	1.1E-06	1.0E+01	5.6E-08	1.2E+01	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOKVS	14	N/A	--	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--
VOMVC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOFGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01

See notes at end of table.

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TABLE 8-17 (Continued)

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)
Scenario Frequencies and Range Factors

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR
VOFHC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	5.6E-08	1.2E+01	3.3E-09	1.3E+01	N/A	--
VOFVC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOQGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOQVC	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VORGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VORVC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOSVS	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01
VOWGS	14	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.4E+01	N/A	--
VODHC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.5E-10	5.0E+01	2.2E-09	5.1E+01	N/A	--
VOCGC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	N/A	--
VOCHC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.5E-10	5.0E+01	N/A	--	N/A	--
VOMVC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.5E-10	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VOFGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VOFHC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	2.5E-10	5.0E+01	2.2E-09	5.1E+01	N/A	--
VOFVC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VOQGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VOQVC	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VORGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	5.4E-15	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01
VORVC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	5.4E-15	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01

NOTES: 1. Scenarios 1-5 are per truck mile; scenarios 6-15 are per exposure year.
2. Duration time shown for scenarios with agent releases due to both detonations and spills is for spills only. Duration time for detonation is instantaneous.

8.2. UNCERTAINTY ANALYSIS

The results of the uncertainty analysis indicate that the 95th percentile values may be up to 140 times higher than the reported median values. Table 8-18 presents the error factors used. Where sufficient statistical data exist to establish the 95th percentile values, they are reflected in the smaller error factors assigned to these events, which usually range from 3 to 5. Otherwise, the error factors were based on engineering judgment. The guidelines for assigning error factors presented in Section 5 were also applied here.

TABLE 8-18
ONSITE TRANSPORTATION DATA
(Onsite Package)

Event No.	Name	Probability	Range Factor
BE31	Truck collision/overturn	1.38×10^{-7}	20
BE68	Crush force generated	1.00	--
BE73	Crush force agent containment (crush >50,000 lb)	1.00×10^{-1}	2
BE60	Impact force generated	1.00	--
BE71	Impact force fails containment	Negl.	--
BE64	Probe generated	1.64×10^{-2}	3
BE67	Probe fails agent containment (V/R >100/s)	2.4×10^{-2}	2
BE62	Fire generated	1.69×10^{-1}	2
BE63	Fire has heat and duration to detonate burster (>15 min)	1.00×10^{-6}	50
BE31A	Truck collision/overturn. Same as BE31		
BE61 (R)	Impact force sufficient to detonate rocket	2.00×10^{-3}	5
BE52′	Mechanical forces destroy ONC	1.00×10^{-2}	3
BE62A	Fire occurs given truck collision/overturn	7.00×10^{-2}	2
BE61	Undue force sufficient to detonate burster	2.20×10^{-5}	25
BE75	Thermal force fails agent containment (>15 min)	1.00×10^{-6}	50
BE31 (Aircraft)	Aircraft crash occurs at:		
	APG	1.30×10^{-7}	10
	ANAD	1.10×10^{-9}	10
	LBAD	5.00×10^{-10}	10
	NAAP	9.10×10^{-9}	10
	PBA	2.00×10^{-9}	10
	PUDA	8.40×10^{-9}	10
	TEAD	2.80×10^{-10}	10
	UMDA	1.80×10^{-9}	10
BE60	Impact for only (no fire)	5.50×10^{-1}	--
BE71	Impact force fails containment	1.00	--

TABLE 8-18 (Continued)

Event No.	Name	Probability	Range Factor
BE60/62	Impact and fire generated	4.5×10^{-1}	--
BE31 (EQ)	Earthquake occurs (>0.5 g):		
	TEAD	1.00×10^{-4}	10
	NAAP	2.00×10^{-5}	10
	Elsewhere	6.00×10^{-6}	10
BE68	Crush force generated	1.00	--
BE62 (EQ)	Fire generated (Same as BE62A)		
BE31 (Tornado)	Tornado occurs (winds >160 mph):		
	TEAD, UMDA	3.33×10^{-7}	10
	PUDA, APG	5.56×10^{-6}	10
	Elsewhere	1.04×10^{-4}	10
BE31′	Trucks caught in bad weather	1.00×10^{-1}	2
BE64	Tornado-generated missile capable of failing containment (>250 mph):		
	TEAD, UMDA	5.40×10^{-3}	10
	PUDA, APG	1.80×10^{-2}	10
	Elsewhere	1.40×10^{-2}	10
BE51	Missile fails containment	5.30×10^{-5}	50
BE64A	Probe generated	1.64×10^{-2}	3

8.3. REFERENCES

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9. QUANTIFICATION BASES

9.1. DATA BASE

9.1.1. Truck Accident Data

The truck convoy accident data summarized here was developed by SNL (Ref. 9-1). These data represent the most comprehensive information currently available and they are commonly used for truck transportation risk analyses. Therefore, an explanation of their bases will not be presented here. A 1987 report by the Lawrence Livermore National Laboratory for the Nuclear Regulatory Commission (Ref. 9-2), describing highway accidents involving spent fuel shipping casks, was reviewed; the more recent data was found to be consistent with the SNL data (Ref. 9-1). Therefore, no changes will be made in the data used for this analysis. The SNL analyses considered five accident forces: impact, crush, puncture, fire, and immersion. Only the first four are discussed here because immersion is not considered a threat for onsite transportation.

The effect of human factors on the truck accident rate is implicit in the SNL data base. If an accident occurred due to human error, it shows up in the data base just as an accident. Therefore, it is not possible to ascertain the human error contribution or to define the human error probabilities involved. No specific human reliability analysis was done for onsite transportation. Several administrative controls will be instituted, however, and these have the effect of reducing the SNL truck accident rate as shown on Table 9-1 and discussed in Section 8.

TABLE 9-1
TRUCK ACCIDENT RATE[a]

Munitions Vehicle Accident Type	Highway Accident Rate (Per Mile)	Convoy Accident Rate (Per Mile)
Head-on collision	4.7×10^{-7}	0
Rear-end collision	3.8×10^{-7}	3.8×10^{-8}
Rear-end collision	4.0×10^{-7}	4.0×10^{-8}
Side-on into collision	1.5×10^{-7}	0
Side-on by other collision	2.3×10^{-7}	0
Truck/train collision	1.6×10^{-8}	0
Fixed object collision	4.3×10^{-7}	4.3×10^{-8}
Overturn only	1.7×10^{-7}	1.7×10^{-8}
Subtotal (collision/ overturn events)	2.47×10^{-6}	1.38×10^{-7}
Fire only	2.8×10^{-8}	2.8×10^{-8}
Total	2.5×10^{-6}	1.66×10^{-7}

[a]Probability (collision or overturn/truck accident) =

$$\frac{1.38 \times 10^{-7}}{1.66 \times 10^{-7}} = 0.831 \quad .$$

$$\text{Probability (fire only/truck accident)} = \frac{2.8 \times 10^{-8}}{1.66 \times 10^{-7}} = 0.169 \quad .$$

9.1.2. Plant Accident Data

Component failure data that support all of the fault trees and event trees are presented on the following pages; references are also provided. The data used to quantify the fault tree events are also presented on the fault trees. Beta factors are used to quantify failure probabilities for identical redundant components. The beta factors are also shown on the fault trees.

The derivation of the failure rates used in this study was based on extensive review and analysis of data available in the literature. When a sufficient number of estimates (at least 10, but usually many more) was available for a component failure rate, the method described in "Reliability Engineering"* was used to develop a nonparametric distribution of estimates. The 0.5 percentile of this distribution was used as the median of a lognormal distribution of parameter estimates. The 0.95, 0.50, and 0.05 percentiles of the nonparametric distribution were used to develop an error factor for the lognormal distribution.

When less than 10 estimates were available for a particular component, a most applicable estimate was subjectively selected to represent the median of a lognormal distribution. The error factor was also selected subjectively, but it was verified that the corresponding lognormal distribution was consistent with the other available estimates.

Fan Fails Off - 0.13/yr (EF = 30)

The Corps of Engineers (HND) R/M Data Base (Ref. 9-4) provides failure rates for fans (all failure modes combined) ranging from 0.9 to 9.17 per million hours. NPRD-3 (Ref. 9-5, pages 201-202) provides a

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*ARINC Research Corporation, "Reliability Engineering," Prentice-Hall, Inc., 1964, p. 144.

range from 2 to 25 failures per million hours for fans operating under selected environmental conditions (data from GF and NS environmental codes only). Review of the failure mode descriptions in the NPRD-3 report, however, reveals that no more than about 51% of all failure events are relevant to the failure mode of interest here. Thus, the failure rate estimates from these two sources range from about 0.5 to 13 failures per million hours.

NPRDS (Ref. 9-6, pages 287-289) reports a total of 48 fan/blower failures in about 4.06 million operating hours. The failure modes described in the NPRDS report were examined to screen those that do not apply to the event of interest. This review indicates that only 23 events can be associated with the failure mode of interest. Thus, the failure rate is about 5.7×10^{-6}/h.

SRS (Ref. 9-7, item code 663°) provides four fan failure rate estimates ranging from 261 to 867 failures per million operating hours. These estimates were reduced by 50% to screen failure modes that do not apply to this event (the 50% reduction is based on both the NPRD-3 and NPRDS failure mode reviews).

All these sources combined provided a total of 21 failure rate estimates. These estimates were used to develop a distribution of fan failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median and error factor developed from this distribution are 1.5×10^{-5}/h and 30, respectively.

<u>Motor Fails to Run</u> - 0.061/yr (EF = 20)

The Rijnmond study (Ref. 9-8, Table IX.I) suggests a failure rate range from 0.5 to 100 (median = 7, EF = 14) failures per million hours for a motor failing to run.

NPRDS (Ref. 9-6, pages 403-409) reports a total of 48 ac motor failures in about 5.2 million operating hours. The failure modes described in the NPRDS report were examined to screen those that do not apply to the event of interest, and only about 15 failures were judged applicable here. Thus, the NPRDS estimate is 2.9 x 10^{-6}/operating hour.

NPRD-3 (Ref. 9-5, pages 199-201) provides a range from 0.5 to 250 failures per million operating hours under selected environmental conditions (data from DOR, GB, GF, and NS environmental codes only). Review of the failure mode descriptions in the NPRD-3 report, however, reveals that no more than about 77% of all failure events are relevant to the failure mode of interest. Thus, the failure rate range from this source is from 0.4 to 193 failures per million operating hours.

WASH-1400 (Ref. 9-9, Table III.4-2) suggests a median of 10 x 10^{-6}/h with an error factor of 3. SRS (Ref. 9-7, item code 56320) provides ten failure rate estimates for electric motors ranging from 2.9 to 158 failures per million operating hours. These estimates were reduced by 54% to screen failure modes that do not apply to this event (the 54% reduction is an average of the reduction suggested by the NPRD-3 and NPRDS failure mode reviews).

All these sources combined provided a total of 29 failure rate estimates. These estimates were used to develop a distribution of motor failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median and error factor developed from this distribution are 7 x 10^{-6}/h and 20, respectively.

<u>Pump Fails to Run</u> - 0.26/yr (EF = 10)

WASH-1400 reports a failure rate of 3 x 10^{-5}/h with an error factor of 10. This estimate includes both the pump and the driver. SRS

(Ref. 9-7, item code 69530) reports a slightly higher rate (5.4 x 10^{-5}/h) that is in good agreement given the large uncertainty assumed in the WASH-1400 estimate.

NPRDS (Ref. 9-6, pages 421 through 429) reports a total of 509 (<500 GPM) pump failures in about 2.3 million operational hours. The failure modes described in the NPRDS report were examined to screen those that do not apply to the event of interest (e.g., spurious operation). This review indicates that only about 147 of the 509 events can be associated with the failure mode of interest. Thus, the failure rate is about 6.4 x 10^{-5}/operational hour.

NPRD-3 (Ref. 9-5, page 215) reports a failure rate of 7.9 x 10^{-5}/operating hour for oil pumps operating under less than ideal conditions, installed in permanent racks with adequate cooling air, and maintained by military personnel. However, the pump may occasionally be subject to shock and vibration. As for the NPRDS estimate, the failure modes described in the NPRD-3 report were reviewed, and only about 27% of the events were judged applicable to the failure mode of interest. Thus, the failure rate becomes about 2.1 x 10^{-5}/operating hour.

All estimates are in good agreement with the WASH-1400 estimate, and the latter was used in this study. The error factor proposed in the WASH-1400 is also adopted here because both the NPRDS and the NPRD-3 data bases show large variations among failure rate estimates for different pumps and/or for similar pumps at different facilities.

<u>Heater Fails Off</u> - 0.021/yr (EF = 10)

The Corps of Engineers (HND) R/M Data Base (Ref. 9-10, page 296) provides a 2.36/million hour failure rate estimate for a large (30 kw, 400 VAC), two stage heater. NPRD-3 (Ref. 9-5, page 207) provides a range from 0.4 to 3.5 failures per million operating hours for heaters

operating under selected environmental conditions (data from GB environmental code only). NPRDS (Ref. 9-6, page 322) reports 18 heater failures in about 5 million operating hours. Thus, the NPRDS failure rate estimate is about 3.6×10^{-6}/h.

The estimate from the Corps of Engineers (HND) data base (Ref. 9-4) is judged more applicable here and will be used as the median for "heater fails off" event. An error factor of 10 is assumed due to the large uncertainties associated with the applicability of these estimates to the equipment of interest. Note that all estimates are in good agreement given the large uncertainty assumed for this failure rate.

<u>Loss of (Plant or Instrument) Air System</u> - 0.016/yr (EF = 10)

NPRDS (Ref. 9-6, page 49) reports no air system failures in about 398 thousand operating hours (approximately 3.2 million calendar hours). These statistics were compiled from 24 instrument and station service air systems in U.S. nuclear power plants. The median generated from these statistics is about 1.8×10^{-6}/operating hour (using a chi-square distribution).

There are large uncertainties regarding the similarity of the systems at this facility and the systems in the NPRDS data base, and thus, regarding the applicability of the NPRDS estimate to this facility. An error factor of 10 is judged adequate here.

<u>Switch, Generic--Spurious Operation</u> - 0.015/yr (EF = 19)

A review of available data bases (Refs. 9-5 through 9-8 and Refs. 9-11 through 9-13) revealed 53 failure rate estimates for a variety of switches (e.g., pressure, temperature, etc.). These estimates were used to develop a distribution of switch failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median of switch failure rate estimates is about 3.4 failures per million operating hours. This rate was arbitrarily reduced by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation." This reduction is believed to be conservative. The distribution of switch failure rates suggests an error factor of 19.

<u>Controller (includes sensor, signal conditioning equipment, and control circuitry), Generic--Spurious Operation (high or low)</u> - 0.022/yr (EF = 12)

A review of available data bases (Refs. 9-5, 9-6, 9-8, 9-10, 9-12) revealed 19 failure rate estimates for a variety of controllers (e.g., pressure, thermostat, electronic, etc.). These estimates were used to develop a distribution of controller failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median of the controller failure rate estimates is about five failures per million operating hours. This rate was reduced by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation" (functions without signal). This reduction is suggested in the IEEE Std. 500-1977 data base. The distribution of controller failure rates suggests an error factor of 12.

<u>Pressure Controller (includes sensor, signal conditioning equipment, and control circuitry)--Spurious Operation (high or low)</u> - 0.007/yr (EF = 12)

A review of available data bases (Refs. 9-5, 9-6, 9-10, 9-12) revealed seven failure rate estimates for pressure controllers. These estimates were used to develop a distribution of pressure controller failure rates.

The median of the pressure controller failure rate estimates is about 1.6 failures per million operating hours. This rate was reduced

by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation." This reduction is suggested in the IEEE Std. 500-1977 data base.

The error factor for a generic controller, EF = 12, is adopted here for pressure controllers because the seven estimates available for pressure controller failure rates are judged insufficient to represent the spread of the distribution.

<u>Pump Fails to Start</u> - 5.1×10^{-3}/demand (EF = 10)

WASH-1400 suggests a 10^{-3}/demand probability of a pump failing to start, with an error factor of 10. This same estimate has been adopted in several other applications, including the Rijnmond study (Ref. 9-8, Table IX.I) and EGG-EA-5887 (Ref. 9-14, page 12). The WASH-1400 estimate is used in this study.

Also, a 4.1×10^{-3}/demand probability is added to this estimate to account for cable, circuit breaker (CB), and CB control circuit faults (Ref. 9-15, Table B.5-5).

<u>Relief Valve Spuriously Opens</u> - 0.01/yr (EF = 5)

WASH-1400 suggests a 10^{-5}/h (0.09/yr) estimate with an error factor of 3. A more recent study, EGG-EA-5887 (Ref. 9-39, page 18), proposes a lower, 10^{-2}/yr, estimate with the same error factor. The more recent estimate is assumed for this event, but the error factor has been increased to 5 to reflect uncertainties with respect to applicability of nuclear-related data to the demilitarization facility.

<u>Beta-Factor, Generic</u> - 0.14 (EF = 4)

A review of available literature and data bases (Ref. 9-11 and Refs. 9-16 through 9-21) on CCFs revealed 80 beta-factor estimates for

a variety of equipment (e.g., pumps, diesel generators, instrumentation and control equipment, etc.). These estimates were used to develop a distribution of beta-factor values, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study. The median of the beta-factor estimates is about 0.14 with an error factor of 4.

Solenoid Valve Beta-Factor - 0.15 (EF = 4)

The event "Solenoid Valve Fails to Operate on Demand" includes a contribution from the solenoid valve itself and a contribution from the valve relay.

The generic beta-factor, 0.14, was used for the solenoid valve, and the breaker beta-factor, 0.19 (Ref. 9-17), was used for the valve relay. The overall beta-factor for this event is the average of these two beta-factor estimates, weighted by their contribution to the event probability:

$$\beta = \frac{0.14 \times 10^{-3} + 0.19 \times 10^{-4}}{10^{-3} + 10^{-4}} = 0.15 \quad .$$

Damper Beta-Factor - 0.14 (EF = 4)

The generic beta-factor was assumed applicable for dampers.

Loss of Offsite Power - 0.09/yr (EF = 5)

NUREG/CR-3992 (Ref. 9-22, Table 5.1) estimated the frequency of loss of offsite power to be 0.09/yr based on industry-wide U.S. nuclear power plant data for the years 1959 through 1983. This estimate was derived from plants with at least two offsite power connections (this includes most nuclear power generating plants). An error factor of 5 is subjectively assigned to this event.

Loss of Offsite Gas Supply - 0.01/yr (EF = 10)

This is a subjective estimate.

Spurious Signal Generated by Control System - 0.014/yr (EF = 10)

A plant specific analysis (Ref. 9-23) of a digital control system indicated a 1.6×10^{-6}/h frequency of spurious system operations resulting in a spurious signal to a specific component; e.g., commanding a valve to close, given appropriate inputs to the system. (This is not the total frequency of spurious system operations.) An error factor of 10 is assigned due to large uncertainties associated with the applicability of this estimate to the control system at the demilitarization facility.

Solenoid Valve Spuriously Closes - 0.0042/yr (EF = 10)

NUREG/CR-2770 (Ref. 9-21, page 92) estimated the frequency of motor-operated valves failing to remain open to be 4.8×10^{-7}/h. Review of the descriptions of the failure occurrences used in deriving this estimate shows that all spurious closings of valves were due to command faults where a support function fault resulted in a spurious signal to close the valve (e.g., bad switch caused closing contact to stick). Thus, since this frequency estimate does not appear to depend on the type of driver, it is judged applicable to this event.

An error factor of 10 is assigned due to large uncertainties associated with the applicability of nuclear-related data to the demilitarization facility.

Check Valve Fails to Open - 10^{-4}/demand (EF = 5)

WASH-1400 provides a 10^{-4} probability of a check valve failing to open on demand, with an error factor of 3. The same estimate is proposed in EGG-EA-5887 (Ref. 9-14, page 13). NUREG/CR-2770 (Ref. 9-21, page 62) provides a 3.1 x 10^{-7}/calendar hour estimate. This estimate is consistent with the WASH-1400 estimate if the valve is tested monthly.

The WASH-1400 estimate is assumed for this event, but the error factor is increased to 5 to reflect uncertainties associated with the applicability of nuclear-related data to the demilitarization facility.

Control (Modulating) Valve Spuriously Opens or Closes - 0.0042/yr (EF = 10)

The same estimate for "Solenoid Valve Spuriously Closes" is used here. The large uncertainty range (EF = 10) is considered sufficient to accommodate equipment variability.

Note: Spurious signals generated by the control system are not included in this estimate.

Damper Spuriously Closes - 0.0042/yr (EF = 10)

The same estimate for "Solenoid Valve Spuriously Closes" is used here. The large uncertainty range (EF = 10) is considered sufficient to accommodate equipment variability.

Pressure Controller Diaphragm Valve Fails (open or closed) - 0.013/yr (EF = 10)

The Corps of Engineers (HND) R/M Data Base (Ref. 9-10, pages 1037, 1038) provides an estimate of 3 x 10^{-6}/h for the frequency of failure of pressure regulation valves. A 50% chance of failing either open or closed is assumed here. The assumed error factor is 10.

Level Indicator--Spurious Operation - 0.06/yr (EF = 4)

A review of available data bases (Refs. 9-5 through 9-8, and Ref. 9-12) revealed ten failure rate estimates for level switches, level sensors, and level transmitters. These estimates were used to develop a distribution of level indicator failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median of level indicator failure rate estimates is about 0.12 failures per operating year. This rate was arbitrarily reduced by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation." This reduction is believed to be conservative. The distribution of level indicator failure rates suggests an error factor of 4.

Temperature Detector--Spurious Operation - 0.095/yr (EF = 6)

A review of available data bases (Refs. 9-5 through 9-8, 9-12, and 9-13) revealed seventeen failure rate estimates for temperature switches, temperature indicators, and temperature transducers. These estimates were used to develop a distribution of temperature detector failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median of temperature detector failure rate estimates is about 0.19 failures per operating year. This rate was arbitrarily reduced by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation"; this reduction is believed to be conservative. The distribution of temperature detector failure rates suggests an error factor of 6.

Solenoid Valve Fails to Operate on Demand - 1.1 x 10^{-3}/demand (EF = 5)

The IREP data base (Ref. 9-24) proposes a 10^{-3}/demand probability for this event, with an error factor of 3. The IREP estimate is adopted in this study, but the error factor has been increased to 5 to reflect the uncertainty associated with the applicability of the IREP data to the demilitarization plant equipment. Also, a 10^{-4}/demand probability is added to this estimate to account for the valve relay failure to open on demand (see Relay/Breaker Fails to Operate).

Pressure Switch--Spurious Operation - 0.037/yr (EF = 5)

A review of available data bases (Refs. 9-5 through 9-8, 9-11, 9-13, 9-24, and 9-25) revealed thirteen failure rate estimates for a variety of pressure switches. These estimates were used to develop a distribution of pressure switch failure rates, and this distribution was used to develop conservative parameters of a lognormal distribution to be used in this study.

The median of pressure switch failure rate estimates is about 0.074 failures per operating year. This rate was arbitrarily reduced by 50% to represent the fraction corresponding to the failure mode of interest, i.e., "spurious operation"; this reduction is believed to be conservative. The distribution of pressure switch failure rates suggests an error factor of 5.

Damper Fails to Operate on Demand - 1.1 x 10^{-3}/demand (EF = 10)

The same probability assumed for a solenoid valve failing to operate on demand is used here. The error factor has been increased to 10 to account for equipment differences.

Relay/Breaker Spuriously Open - 8.8×10^{-5}/yr (EF = 10)

The IREP data base (Ref. 9-24, Table 5.1-1) proposes a failure rate of 10^{-8}/h for loss of an electrical bus, with an error factor of 10. The loss of a bus event is dominated by failure of the supply breaker; thus the IREP estimate is used here for a relay/breaker spuriously opening.

Relay/Breaker Fails to Operate - 10^{-4}/demand (EF = 10)

The IREP data base (Ref. 9-24, Table 5.1-1) proposes a 10^{-4}/demand probability of a relay failing to operate on demand, with an error factor of 10.

Circuit Breaker Fails to Operate - 10^{-3}/demand (EF = 10)

The IREP data base (Ref. 9-24, Table 5.1-1) proposes a 10^{-3}/demand probability of a circuit breaker failing to operate on demand, with an error factor of 10.

Solid State Relay Fails to Operate - 1.8×10^{-4}/demand (EF = 5)

MIL-HDBK-217D (Ref. 9-25) provides a failure rate estimate of 0.5×10^{-6}/h for a solid state (thyristor) relay (assuming GF conditions in Table 5-2-10 and a quality factor of 5 in Table 5-2-11). This estimate results, with an assumed monthly test scheme, in a 1.8×10^{-4} probability of failure on demand. The assumed error factor for this event is 5.

9.1.3. Handling Accident Data

All initiating event frequency accidents, except for forklift collisions, were derived from the human reliability analysis and are discussed in Section 9.2.

The forklift collision accident frequency was derived from Ref. 9-1. In Ref. 9-1, accidents were defined to include incidents that result in fatalities, injuries, or property damage. The basic truck accident rate is 2.5×10^{-6} accidents/mile. From Table II of Ref. 9-1, the percent of accidents leading to collisions with trucks, autos, and stationary objects and overturns is 89.35%. Table III of Ref. 9-1 also show that 50% of all accidents occur at 30 to 40 mph.

To convert the basic rate to accidents per operation, the operator's exposure time in the highway is determined. If the operator was traveling at 35 mph, the exposure time is 1.7 min.

In order to apply this information to forklift collision accidents, the following were assumed:

1. The total operator exposure time during the forklift operation is 10 min. This includes the lifting of munitions from the stack, moving them to another area, and unloading them.

2. The time to travel from one point to another is assumed to be one-third of the total time, or 3.3 min.

3. Forklift collisions will occur at speeds no greater than 40 mph (i.e., two forklifts traveling at 20 mph).

Therefore, forklift collision accident rate is:

$$2.5 \times 10^{-6} \times 0.893 \times \frac{3.3}{1.7} = 4.3 \times 10^{-6}/\text{operation} \quad .$$

This median value is assigned an error factor of 10 on the basis that the data is only for 6 yr and there may be other unreported incidents more directly related to forklift operations.

Reference 9-1 also indicates that 25% of fires result from collision-type accidents. It is not evident from the data if fire from collision is directly proportional to truck speed. Our analysis assumes that it is. Therefore, we modified the data as follows:

$$\text{Probability of fire} = 0.25 \times 0.29 = 0.0725 \quad ,$$

where the factor 0.29 represents the percent of collisions occurring at less than 20 mph.

9.2. HUMAN FACTORS DATA

9.2.1. Human-Error Probability Estimation - Handling Accidents

Human-error probabilities were quantified for use in the handling scenarios using the approach to human-error estimation described in NUREG/CR-1278 (Ref. 9-26), probabilities of human errors were estimated based on several performance-shaping factors such as munition configuration, handling operation, clothing level, and crew size. These factors are identified in the discussions that follow on the derivations of each estimate. Table 9-2 lists the error probabilities estimated for puncturing or dropping a munition based on each of these factors. These error probabilities will be incorporated into the handling scenarios as shown in the data tables in Table 9-3.

1. Puncturing a munition. The basis for the error estimates is taken from Section 4.4.2 of Ref. 9-27 (pages 4.4 through 4.26). This reference gives 4×10^{-5} as a data-based estimate of the probability of handling errors using forklifts for the rocket stockpile. This is an estimate of the likelihood of an error in forklift operation that potentially could lead to a warhead rupture while attempting to isolate a leaking rocket inside the storage igloo.

   That estimate is based on conditions that do not entirely represent those assumed by this study; namely, that a three-man crew will perform all forklift operations. In this study, it is assumed that a two-man crew will perform all forklift operations--one driving the forklift and one guiding forklift and munition position from the ground. This means that the data-based estimate may not represent the probability of forklift-handling errors expected under actual conditions. Therefore, this estimate was revised to 1×10^{-4} to account

TABLE 9-2

HUMAN ERROR PROBABILITIES PER HANDLING OPERATION

Error Type For Munition Configuration	Handling Operation for Clothing Type					
	Level A or DPE		Levels B, C, and D (Mask, Gloves, and Boots)		Levels E and F (Street Clothes, Mask Slung)	
	Hand Carry[a]	Forklift	Hand Carry[a]	Forklift	Hand Carry[a]	Forklift
Tine Carried						
Drop	6.0×10^{-4}	3.0×10^{-4}	3.0×10^{-4}	1.5×10^{-4}	6.0×10^{-5}	3.0×10^{-5}
Puncture	NA	1.0×10^{-4}	NA	5.0×10^{-5}	NA	1.0×10^{-5}
Beam Carried						
Drop	NA	3.0×10^{-5}	NA	1.5×10^{-5}	NA	3.0×10^{-6}
Puncture	NA	NA	NA	NA	NA	NA

[a] Hand-carry operations involve one weapon at a time.

TABLE 9-3
DATA BASE FOR LEAKERS IN STORAGE

Event		Frequency or Probability	Reference
Munition develops a leak during storage (Scenario SL1):			
Bomb	(TEAD)	7.5E-5 per yr	Ref. 5-20
	(UMDA)	4.5E-4 per yr	
4.2-in. mortar	(ANAD)	2.8E-7 per yr	
	(PUDA)	1.0E-6 per yr	
	(TEAD)	7.0E-6 per yr	
105-mm cartridge	(ANAD)	2.8E-7 per yr	
	(PUDA)	1.0E-6 per yr	
	(TEAD)	7.0E-6 per yr	
Ton container		5.9E-6 per yr	
Mine	(ANAD)	9.0E-6 per yr	
	(PBA)	1.1E-6 per yr	
	(TEAD)	2.5E-4 per yr	
	(UMDA)	3.1E-4 per yr	
Projectile	(ANAD)	4.9E-6 per yr	
	(LBAD)	9.3E-6 per yr	
	(PUDA)	5.0E-6 per yr	
	(TEAD)	8.1E-5 per yr	
	(UMDA)	6.2E-5 per yr	
Rocket	(ANAD)	6.1E-5 per yr	
	(LBAD)	4.3E-5 per yr	
	(PBA)	9.1E-7 per yr	
	(TEAD)	1.3E-3 per yr	
	(UMDA)	1.8E-4 per yr	
Spray tank		9.8E-5 per yr	
Forklift tine accident (SL2)		1.0E-4 per oper.	Ref. 5-17
Munition punctured given tine accident:			
Bomb		1.29E-2	Ref. 5-2
4.2-in. mortar		3.68E-2	
105-mm cartridge		3.90E-3	
Mine		7.07E-2	
Projectile		5.00E-2	

TABLE 9-3 (Continued)

Event	Frequency or Probability	Reference
Rocket	2.63E-1	
Spray tank	1.53E-2	
Munition dropped during leaker isolation (SL9):		
Pallet and bulk (B, S)	3.0E-4	Human Reliability Analysis (Ref. 5-17)
Single (C,D,M,P,Q,R)	6.0E-4	
Ton container (K)	3.0E-5	
Munition punctured given drop:		
Bomb (pallet)	4.72E-4	Ref. 5-2
(single)	1.62E-4	
4.2-in. mortar (pallet)	1.24E-4	
(single)	0.0	
105-mm cartridge (pallet)	2.71E-5	
(single)	0.0	
Ton container	1.55E-3	
Mine (pallet)	9.27E-5	
(single)	4.08E-5	
Projectile (pallet or single)	0.0	
Munition detonates given drop:	1.6E-8/munition	Ref. 5-2
Forklift collision leads to drop of munitions	4.3E-6/oper.	Ref. 5-12 and Ref. 5-2
Collision results in fire	0.0725	Ref. 5-12
Fire contained:		
Burstered (4 min)	0.5	Engineering judgement
Nonburstered (30 min)	1.00	Fuel will be limited so as limit fire to less than 10 min

for a smaller crew. The revised estimate of 1×10^{-4} is the probability that one or both members of a two-man crew will err such that the forklift tine is in a position to puncture a munition. (This puncture probability applies to those cases in which forklift tines are used to lift munitions; it includes palletized munitions and spray tanks in overpacks.)

Another difference is that the original estimate from Ref. 9-27 (4×10^{-5}) was based on operations with leaking rockets. This meant that it assumes that the crew is wearing Level A protective clothing. If the same forklift operations are performed in less strenuous circumstances (i.e., if a lower level of protective clothing is worn), the error probability estimate can be lowered. Here, it has been lowered to 5×10^{-5} for the case of the operators' wearing partial protection (masks, gloves, and boots) and to 1×10^{-5} for the case of their wearing minimal protection (street clothes, with masks slung).

2. Dropping a munition. For palletized munitions and spray tanks in their overpacks, human-caused drops from forklifts are judged to be three times as likely as punctures caused by operating the same kind of forklift. The error-probability estimates are 3×10^{-4}, 1.5×10^{-5}, and 3×10^{-5} for dropping a munition from a forklift tine when wearing Level A, Level C, or Level F protective clothing, respectively.

   Because of unwieldy pallet and overpacked spray tank loads, and because it is assumed that forklift-tine loads are likely to be carried at higher speeds than are forklift-beam loads, the likelihood of a ton container or other beam-carried loads being dropped because of human error is judged to be an order of magnitude lower than that of a tine-carried load being

dropped. These are estimated to be 3×10^{-5}, 1.5×10^{-6}, and 3×10^{-6} for protective clothing Levels A, C, and F, respectively.

For hand-carried munitions, munition drops are estimated to be twice as likely as drops of tine-carried load from forklifts. The estimated probabilities of dropping a hand-carried munition when wearing Levels A, C, and F protective clothing are 6×10^{-4}, 3×10^{-4}, and 6×10^{-5}, respectively. (Loads carried by forklift beams are never hand carried.)

These probability estimates are the likelihood of an error per handling operation. A single forklift operation may involve a single munition such as a spray tank or as many as 48 weapons on a pallet, while a single hand-carry operation will always involve only a single munition.

3. Failing to detect a leaking munition in a package. The probability of an operator's failing to detect a leak is based on his failing to monitor a package before opening it. The error probability is estimated as 1×10^{-3} based on item 9 from Table 20 through 22 of NUREG/CR-1278 (Ref. 9-26). This human-error probability is the probability that a checker will fail to check equipment status when that status affects the checker's own safety. Since the containers are loaded elsewhere (or at least by other operators), the unloader should be cautious when handling them; he has no way to ensure a "clean" vault interior, so he will probably want to protect himself. This error estimates that the operator is likely to overlook this check on one out of every thousand vaults or transportation containers that he opens.

9.2.2. Human-Reliability Analysis for Plant Operations

The human-reliability analysis (HRA) for plant operations was conducted as an input to the plant operations internal events analysis. This section describes the scope of the HRA, the methodology used, the screening performed, and the final quantification.

9.2.2.1. Scope. The preliminary fault-tree and event-tree models for plant operations were examined to identify human actions that had the potential to mitigate agent release. For screening, these human actions were categorized and assigned conservative human-error probabilities. Once the plant operations scenarios had been screened on the basis of frequency and consequence, the survivors were examined in greater detail to identify important human actions and to identify plant/operating system characteristics that could influence human-error probabilities. The important human actions were quantified, taking this information into account, and were integrated into the final fault-tree and event-tree models.

9.2.2.2. Methodology. Screening and final estimates of human-error probabilities were obtained by using the Technique for Human Reliability Analysis (THERP) as described in NUREG/CR-1278 (Ref. 9-26). This technique calls for identifying individual human errors and for describing the set of performance-shaping factors (PSFs) that pertain to each task situation. Usually, such descriptions are very task-, site-, and situation-specific. In this case, since there was no finished, approved human-performance system to analyze, more generic descriptions of task situations were used. That is, several assumptions about what could be realistically expected for a generic CONUS site were made, since there are, as yet, no written procedures for CONUS, no site-specific man-machine interface, no training program beyond the conceptual stage, and no finished plant design (except that for JACADS) that allows for time data to be collected. The human-reliability analysis for plant operations was based on these assumptions, which are listed in Appendix E.

9.2.2.3. Screening. To screen the plant-operations scenarios, generic human-error events were defined. The plant-operations logic models (fault trees and event trees) were examined to identify appropriate areas for considering the human-error contribution to release frequencies. At appropriate places on these logic models, one or more of the generic human-error events were placed, or it was determined that the human-error contribution had already been taken into account there implicitly.

Conservative human-error probabilities were estimated for each of the error events. The conservative estimates may be considered to represent the upper bound of a worst-case human-action situation. The screening human-error events are described in Table 9-4 along with the data source for each error probability. In general, the HEPs used for screening purposes are either (1) factors of 3 to 10 higher than the upper bounds reported in Ref. 9-26, (2) taken to be 1.0, or (3) conservative values are assumed based on analyst experience and scientific judgment. Once these conservative values had been used in the quantitative scenario screening, more realistic human-error probabilities were estimated for the surviving scenarios.

9.2.2.4. Final Quantification. A preliminary draft of the event trees was examined to identify any human actions that might serve as initiators to, or mitigators of, accident scenarios. Those human actions were categorized according to the system or equipment interface dealt with by the operators. (As is usual with other risk assessments, human errors in maintenance activities were not quantified explicitly since those errors contribute to the already-estimated hardware-failure probabilities.) Table 9-5 lists those human actions in scenario-identifier order.

For final quantification, this list was grouped according to error types. Ten error types were identified that focus on: ignition, fire suppression, conveyor loading, munition counting, tank overfill, sump

TABLE 9-4
SCREENING QUANTIFICATION FOR HUMAN-RELIABILITY
ANALYSIS OF PLANT OPERATIONS

Index	Error Event	HEP	Source[a]
1	Operator fails to respond to an alarm indication. Correct response is in the control room and may include taking simple control action or initiating emergency shutdown.	1×10^{-1}	Table 20-23, item 2b (factor of 10 higher than upper bound)
2	Operator fails to respond to an alarm indication. Correct response is outside the control room, and Decontamination Protective Ensemble (DPE) may be required.	3×10^{-1}	(Factor of 3 above Index 1)
3	Operator fails to notice a malfunction or existing condition on the closed-circuit TV screen. He fails to shut the operation down as a result.	5×10^{-1}	Table 20-10, item 7 (upper bound (or Table 20-22, item 4 (factor of 10 above upper bound)
4	Operator fails to monitor the operating system. He fails to carry out a required action such as closing a valve or closing a blast door.	3×10^{-1}	Table 20-6, item 2 (factor of 10 above upper bound)
5	Operator shuts down, disables, or delays the operation of a safety system. This could be because he misinterprets system status or because the information he received is incorrect or incomplete.	1×10^{-1}	Table 20-3, item 2 (by 10 minutes after signal)
6	Operator takes action that initiates a fire or some other sequence of catastrophic events.	1×10^{-2}	Scientific judgment
7	Operator fails to take action to mitigate fire. He fails to close the dampers.	1.0	Table 20-3, item 2 (by 10 minutes, upper bound)
8	Operator fails to implement action to recover from upset condition.	1.0	Scientific judgment

TABLE 9-4 (Continued)

Index	Error Event	HEP	Source[a]
9	Maintainer fails to perform tasks, to perform them correctly, or to perform them on time.	3×10^{-1}	Table 20-6, item 7
10	Operator fails to carry out administrative control policy. He fails to initiate a regularly scheduled action or fails to follow standard operating procedure.	5×10^{-1}	Table 20-6, item 1 (factor of 10 above upper bound)
11	Operator selects wrong component to operate.	5×10^{-2}	Table 20-12, item 2 (factor of 5 above upper bound)
12	Operator drops or damages munition while controlling it manually, lifting or carrying it with a forklift, or carrying it by hand.	3×10^{-1}	Scientific judgment

[a]Unless stated otherwise, all tables and item numbers refer to NUREG/CR-1278 (Ref. 9-26).

TABLE 9-5
HUMAN-ERROR EVENTS BY SEQUENCE

No.	Error Events	Area	Munition	Sequence
1	Conveyor Loading	ECV	Ton Container	ECV-1
2	Ignition	ECV	Ton Container	ECV-1
3	Fire Suppression	ECV	Ton Container	ECV-1
4	Ventilation System	ECV	Ton Container	ECV-1
5	Conveyor Loading	ECV	Ton Container	ECV-2
6	Ignition	ECV	Ton Container	ECV-2
7	Fire Suppression	ECV	Ton Container	ECV-2
8	Conveyor Loading	ECV	M55 Rocket	ECV-3
9	Conveyor Loading	ECV	M55 Rocket	ECV-4
10	Fire Suppression	ECV	M55 Rocket	ECV-4
11	Conveyor Loading	ECV	M55 Rocket	ECV-5
12	Fire Suppression	ECV	M55 Rocket	ECV-5
13	Conveyor Loading	ECV	Mine	ECV-6
14	Conveyor Loading	ECV	Mine	ECV-7
15	Fire Suppression	ECV	Mine	ECV-7
16	Conveyor Loading	ECV	Mine	ECV-8
17	Fire Suppression	ECV	Mine	ECV-8
18	Conveyor Loading	ECV	8" Projectile	ECV-9
19	Conveyor Loading	ECV	8" Projectile	ECV-10
20	Fire Suppression	ECV	8" Projectile	ECV-10
21	Conveyor Loading	ECV	8" Projectile	ECV-11
22	Fire Suppression	ECV	8" Projectile	ECV-11
23	Conveyor Loading	ECV	105-mm Projectile	ECV-12
24	Conveyor Loading	ECV	105-mm Projectile	ECV-13
25	Fire Suppression	ECV	105-mm Projectile	ECV-13
26	Conveyor Loading	ECV	105-mm Projectile	ECV-14
27	Fire Suppression	ECV	105-mm Projectile	ECV-14
28	Conveyor Loading	ECV	105-mm Projectile	ECV-15
29	Conveyor Loading	ECV	105-mm Projectile	ECV-16
30	Fire Suppression	ECV	105-mm Projectile	ECV-16
31	Conveyor Loading	ECV	105-mm Projectile	ECV-17
32	Fire Suppression	ECV	105-mm Projectile	ECV-17
33	Undrained Munition	ECR	Mine	ECR-1DM
34	Ventilation System	ECR	Mine	ECR-1DM
35	Undrained Munition	ECR	Mine	ECR-2DM
36	Ventilation System	ECR	Mine	ECR-2DM
37	Undrained Munition	ECR	Mine	ECR-3DM
38	Ignition	ECR	Mine	ECR-3DM
39	Fire Suppression	ECR	Mine	ECR-3DM
40	Ventilation System	ECR	Mine	ECR-3DM
41	Undrained Munition	ECR	Mine	ECR-4DM
42	Fire Suppression	ECR	Mine	ECR-4DM
43	Ventilation System	ECR	Mine	ECR-4DM
44	Undrained Munition	ECR	Projectile	ECR-1DP
45	Ventilation System	ECR	Projectile	ECR-1DP
46	Undrained Munition	ECR	Projectile	ECR-2DP
47	Ventilation System	ECR	Projectile	ECR-2DP
48	Undrained Munition	ECR	Projectile	ECR-3DP
49	Fire Suppression	ECR	Projectile	ECR-3DP
50	Ventilation System	ECR	Projectile	ECR-3DP
51	Undrained Munition	ECR	Projectile	ECR-4DP
52	Fire Suppression	ECR	Projectile	ECR-4DP

TABLE 9-5 (Continued)

No.	Error Events	Area	Munition	Sequence
53	Ventilation System	ECR	Projectile	ECR-4DP
54	Undrained Munition	ECR	Rocket	ECR-1DR
55	Ventilation System	ECR	Rocket	ECR-1DR
56	Undrained Munition	ECR	Rocket	ECR-2DR
57	Fire Suppression	ECR	Rocket	ECR-2DR
58	Ventilation System	ECR	Rocket	ECR-2DR
59	Undrained Munition	ECR	Rocket	ECR-3DR
60	Fire Suppression	ECR	Rocket	ECR-3DR
61	Ventilation System	ECR	Rocket	ECR-3DR
62	Undrained Munition	ECR	Rocket	ECR-4DR
63	Fire Suppression	ECR	Rocket	ECR-4DR
64	Undrained Munition	ECR	Rocket	ECR-5DR
65	Ventilation System	ECR	Rocket	ECR-5DR
66	Undrained Munition	ECR	Rocket	ECR-6DR
67	Fire Suppression	ECR	Rocket	ECR-6DR
68	Ventilation System	ECR	Rocket	ECR-6DR
69	Undrained Munition	ECR	Rocket	ECR-7DR
70	Fire Suppression	ECR	Rocket	ECR-7DR
71	Ventilation System	ECR	Rocket	ECR-7DR
72	Spurious Drain	MPB	Bulk Container	MPB-2B
73	Ignition	MPB	Bulk Container	MPB-2B
74	Fire Suppression	MPB	Bulk Container	MPB-2B
75	Ventilation System	MPB	Bulk Container	MPB-2B
76	Spurious Drain	MPB	Bulk Container	MPB-3B
77	Ignition	MPB	Bulk Container	MPB-3B
78	Fire Suppression	MPB	Bulk Container	MPB-3B
79	Ventilation System	MPB	Bulk Container	MPB-3B
80	Spurious Drain	MPB	Bulk Container	MPB-4B
81	Fire Suppression	MPB	Bulk Container	MPB-4B
82	Spurious Drain	MPB	Bulk Containers	MPB-5B
83	Fire Suppression	MPB	Bulk Containers	MPB-5B
84	Ventilation System	MPB	Bulk Containers	MPB-5B
85	Spurious Drain	MPB	Bulk Containers	MPB-6B
86	Fire Suppression	MPB	Bulk Containers	MPB-6B
87	Undrained Munition	MPB	Projectile	MPB-1DP
88	Ventilation System	MPB	Projectile	MPB-1DP
89	Undrained Munition	MPB	Projectile	MPB-2DP
90	Fire Suppression	MPB	Projectile	MPB-2DP
91	Ventilation System	MPB	Projectile	MPB-2DP
92	Undrained Munition	MPB	Projectile	MPB-3DP
93	Fire Suppression	MPB	Projectile	MPB-3DP
94	Ventilation System	MPB	Projectile	MPB-3DP
95	Conveyor Loading	BSA	Ton Container	BSA-1
96	Ignition	BSA	Ton Container	BSA-1
97	Fire Suppression	BSA	Ton Container	BSA-1
98	Undrained Munition	BSA	Ton Container	BSA-2
99	Conveyor Loading	BSA	Ton Container	BSA-2
100	Ignition	BSA	Ton Container	BSA-2
101	Fire Suppression	BSA	Ton Container	BSA-2
102	Ventilation System	BSA	Ton Container	BSA-2
103	Sump Pump Operation	TOX	Agent Tank	TOX-2
104	Fire Suppression	TOX	Agent Tank	TOX-2

TABLE 9-5 (Continued)

No.	Error Events	Area	Munition	Sequence
105	Ventilation System	TOX	Agent Tank	TOX-2
106	Sump Pump Operation	TOX	Agent Tank	TOX-3
107	Fire Suppression	TOX	Agent Tank	TOX-3
108	Ventilation System	TOX	Agent Tank	TOX-3
109	Fire Suppression	TOX	Agent Tank	TOX-4
110	Sump Pump Operation	TOX	Agent Tank	TOX-5
111	Fire Suppression	TOX	Agent Tank	TOX-5
112	Ventilation System	TOX	Agent Tank	TOX-5
113	Sump Pump Operation	TOX	Agent Tank	TOX-6
114	Fire Suppression	TOX	Agent Tank	TOX-6
115	Tank Overfill	TOX	Agent Tank	TOX-8
116	Fire Suppression	TOX	Agent Tank	TOX-8
117	Ventilation System	TOX	Agent Tank	TOX-8
118	Tank Overfill	TOX	Agent Tank	TOX-9
119	Fire Suppression	TOX	Agent Tank	TOX-9
120	Shutdown Signal	LIC	All Munitions	LI1-001
121	Stop Fuel	LIC	All Munitions	LI2-001
122	Stop Combustion	LIC	All Munitions	LI2-002
123	Stop Fuel	LIC	All Munitions	LI2-005
124	Shutdown Signal	MPF	Bulk, Projectiles	MP1-001, MP2-005
125	Shutdown Signal	MPF	Bulk, Projectiles	MP2-001, MP2-003
126	Stop Fuel	MPF	Bulk, Projectiles	MP2-002
127	Shutdown Signal	MPF	Bulk, Projectiles	MP2-004
128	Undrained Munition	MPF	Bulk, Projectiles	MP3-001
129	Shutdown Signal	MPF	Bulk, Projectiles	MP3-001
130	Undrained Munition	MPF	Bulk, Projectiles	MP3-002
131	Undrained Munition	MPF	Bulk, Projectiles	MP3-003
132	Undrained Munition	MPF	Bulk, Projectiles	MP3-004
133	Undrained Munition	MPF	Bulk, Projectiles	MP4-001
134	Shutdown Signal	MPF	Bulk, Projectiles	MP4-001
135	Shutdown Signal	MPF	Bulk, Projectiles	MP4-002, MP4-004
136	Stop Fuel	MPF	Bulk, Projectiles	MP4-003
137	Stop Combustion	MPF	Bulk, Projectiles	MP4-005
138	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF1-001, DF2-005
139	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF2-001, DF2-003
140	Stop Fuel	DFS	Bursters, Rockets, Mines	DF2-002
141	Stop Combustion	DFS	Bursters, Rockets, Mines	DF2-004
142	Stop Agent	DFS	Bursters, Rockets, Mines	DF2-006
143	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF2-006
144	Fast Feed	DFS	Bursters, Rockets, Mines	DF3-001
145	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF4-001
146	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF5-001, DF5-003
147	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF5-001, DF5-003
148	Stop Fuel	DFS	Bursters, Rockets, Mines	DF5-002
149	Shutdown Signal	DFS	Bursters, Rockets, Mines	DF5-002
150	Stop Fuel	DFS	Bursters, Rockets, Mines	DF5-004
151	Stop Agent	DFS	Bursters, Rockets, Mines	DF5-005
152	Munition Counting	DUN	All Munitions	DU1-001
153	Munition Counting	DUN	All Munitions	DU1-002
154	Munition Counting	DUN	All Munitions	DU1-003
155	Munition Counting	DUN	All Munitions	DU1-004

pump operation, undrained munition, furnace ventilation, ventilation system, and air compressors. Table 9-6 shows the error events, the area of the plant involved, the munition type involved, the scenario identifier, the error probability, and the error factor associated with each quantification. The data sources for the error types are described below. The data represent medians and error factors of lognormal distributions.

9.2.2.4.1. Ignition. The operator or maintainer could serve as an ignition source in some areas of the plant. For the operators, the credible cases consist of those geographical areas in which he works or traffics. These include the control room, the receiving site Unpack Area (UPA), the Instrumentation and Electric Power room (IEP), and the observation corridors. For the maintainers, these include all areas (although his entry into most areas may be limited to down times). Operators and maintainers could initiate ignition by using an ignition source in the area (e.g., by smoking or welding) or by causing sparks (e.g., by dropping a munition or other object that could create sparks). The first of these will be controlled administratively throughout the plant; the operators will only be allowed to smoke in the control room and outdoors.

For plant areas requiring the wearing of Level C or higher protective clothing, masks must be worn; this physically rules out smoking in these areas. Therefore, smoking as an initiator is credible only in the control room and in the IEP, where Levels E and D, respectively, are required. Smoking even in these areas is a failure of administrative control.

The lower bound of a failure of administrative control is 0.002 (Ref. 9-26, Table 20-6, item 1). The likelihood of a checker's failing to check something when his own safety is involved is 1×10^{-3} (Ref. 9-26, Table 20-22, item 9). The second value was selected as representative of this situation. Given that this failure of administrative control affects their own safety (and assuming that 30% of all

TABLE 9-6
HUMAN-ERROR EVENTS FOR FINAL QUANTIFICATION

No.	Error Events	Area	Munition	Scenario	Sequence	Error Probability	EF
1	Ignition	MPB	Bulk Container		MPB-2B	epsilon	10
2	Ignition	MPB	Bulk Container		MPB-3B	epsilon	10
3	Ignition	ECR	Mine		ECR-3DM	6E-4	10
4	Ignition	BSA	Ton Container		BSA-2	epsilon	10
5	Ignition	ECV	Ton Container		ECV-1	epsilon	10
6	Ignition	ECV	Ton Container	POTAF 043	ECV-2	epsilon	10
7	Ignition	BSA	Ton Container	POKAF 053	BSA-1	epsilon	10
8	Fire Suppression	TOX	Agent Tank		TOX-4	5E-3(5), 2E-4(10), 5E-5(15)	10
9	Fire Suppression	TOX	Agent Tank		TOX-5	5E-3(5), 2E-4(10), 5E-5(15)	10
10	Fire Suppression	TOX	Agent Tank		TOX-9	5E-3(5), 2E-4(10), 5E-5(15)	10
11	Fire Suppression	TOX	Agent Tank		TOX-3	5E-3(5), 2E-4(10), 5E-5(15)	10
12	Fire Suppression	TOX	Agent Tank		TOX-8	5E-3(5), 2E-4(10), 5E-5(15)	10
13	Fire Suppression	TOX	Agent Tank		TOX-6	5E-3(5), 2E-4(10), 5E-5(15)	10
14	Fire Suppression	MPB	Bulk Container		MPB-2B	4E-2(5), 1E-2(10), 4E-3(15)	10
15	Fire Suppression	MPB	Bulk Container	POKAF 051	MPB-4B	4E-2(5), 1E-2(10), 4E-3(15)	10
16	Fire Suppression	MPB	Bulk Container		MPB-3B	4E-2(5), 1E-2(10), 4E-3(15)	10
17	Fire Suppression	ECV	M55 Rocket	PORAC 046	ECV-5	4E-2(5), 1E-2(10), 4E-3(15)	10
18	Fire Suppression	ECV	M55 Rocket	PORAC 045	ECV-4	4E-2(5), 1E-2(10), 4E-3(15)	10
19	Fire Suppression	ECV	Mine	POMVC 045	ECV-7	4E-2(5), 1E-2(10), 4E-3(15)	10
20	Fire Suppression	ECR	Mine		ECR-4DM	4E-2(5), 1E-2(10), 4E-3(15)	10
21	Fire Suppression	ECV	Mine	POMVC 046	ECV-8	4E-2(5), 1E-2(10), 4E-3(15)	10
22	Fire Suppression	ECR	Mine		ECR-3DM	4E-2(5), 1E-2(10), 4E-3(15)	10
23	Fire Suppression	MPB	Bulk Containers		MPB-6B	4E-2(5), 1E-2(10), 4E-3(15)	10
24	Fire Suppression	MPB	Bulk Containers		MPB-5B	4E-2(5), 1E-2(10), 4E-3(15)	10
25	Fire Suppression	MPB	Projectile		MPB-2DP	4E-2(5), 1E-2(10), 4E-3(15)	10
26	Fire Suppression	ECR	Projectile	POPAC 048	ECR-3DP	4E-2(5), 1E-2(10), 4E-3(15)	10
27	Fire Suppression	ECR	Projectile		ECR-4DP	4E-2(5), 1E-2(10), 4E-3(15)	10
28	Fire Suppression	MPB	Projectile		MPB-3DP	4E-2(5), 1E-2(10), 4E-3(15)	10
29	Fire Suppression	ECR	Rocket		ECR-7DR	4E-2(5), 1E-2(10), 4E-3(15)	10
30	Fire Suppression	ECR	Rocket	PORAC 049	ECR-4DR	4E-2(5), 1E-2(10), 4E-3(15)	10
31	Fire Suppression	ECR	Rocket		ECR-3DR	4E-2(5), 1E-2(10), 4E-3(15)	10
32	Fire Suppression	ECR	Rocket	PORAC 048	ECR-6DR	4E-2(5), 1E-2(10), 4E-3(15)	10
33	Fire Suppression	ECR	Rocket		ECR-2DR	4E-2(5), 1E-2(10), 4E-3(15)	10
34	Fire Suppression	BSA	Ton Container		BSA-2	4E-2(5), 1E-2(10), 4E-3(15)	10
35	Fire Suppression	ECV	Ton Container		ECV-1	4E-2(5), 1E-2(10), 4E-3(15)	10

TABLE 9-6 (Continued)

No.	Error Events	Area	Munition	Scenario	Sequence	Error Probability	EF
36	Fire Suppression	ECV	Ton Container	POTAF 043	ECV-2	4E-2(5), 1E-2(10), 4E-3(15)	10
37	Fire Suppression	BSA	Ton Container	POKAF 053	BSA-1	4E-2(5), 1E-2(10), 4E-3(15)	10
38	Conveyor Loading	ECV	105-mm Projectile	POPAC 045	ECV-13	3.3E-4	10
39	Conveyor Loading	ECV	105-mm Projectile	POPAC 046	ECV-14	3.3E-4	10
40	Conveyor Loading	ECV	105-mm Projectile	POPAC 046	ECV-17	3.3E-4	10
41	Conveyor Loading	ECV	105-mm Projectile	POPAC 045	ECV-16	3.3E-4	10
42	Conveyor Loading	ECV	105-mm Projectile	POPAC 044	ECV-12	3.3E-4	10
43	Conveyor Loading	ECV	105-mm Projectile	POPAC 044	ECV-15	3.3E-4	10
44	Conveyor Loading	ECV	8" Projectile	POPAC 046	ECV-11	3.3E-4	10
45	Conveyor Loading	ECV	8" Projectile	POPAC 045	ECV-10	3.3E-4	10
46	Conveyor Loading	ECV	8" Projectile	POPAC 044	ECV-9	3.3E-4	10
47	Conveyor Loading	ECV	M55 Rocket	PORAC 045	ECV-4	3.3E-4	10
48	Conveyor Loading	ECV	M55 Rocket	PORAC 046	ECV-5	3.3E-4	10
49	Conveyor Loading	ECV	M55 Rocket	PORAC 044	ECV-3	3.3E-4	10
50	Conveyor Loading	ECV	Mine	POMVC 044	ECV-6	3.3E-4	10
51	Conveyor Loading	ECV	Mine	POMVC 045	ECV-7	3.3E-4	10
52	Conveyor Loading	ECV	Mine	POMVC 046	ECV-8	3.3E-4	10
53	Conveyor Loading	ECV	Ton Container		ECV-1	1.65E-5	10
54	Conveyor Loading	ECV	Ton Container	POTAF 043	ECV-2	1.65E-5	10
55	Conveyor Loading	BSA	Ton Container		BSA-2	1.65E-5	10
56	Conveyor Loading	BSA	Ton Container	POKAF 053	BSA-1	1.65E-5	10
57	Munition Counting	MDB	Mine		DU1-001	epsilon	NA
58	Munition Counting	MDB	Mine		DU1-003	epsilon	NA
59	Munition Counting	MDB	Mine		DU1-002	epsilon	NA
60	Munition Counting	MDB	Mine		DU1-004	epsilon	NA
61	Tank Overfill	TOX	Agent Tank		TOX-8	1E-3	10
62	Tank Overfill	TOX	Agent Tank		TOX-9	1E-3	10
63	Sump Pump Operation	TOX	Agent Tank		TOX-5	5E-2	10
64	Sump Pump Operation	TOX	Agent Tank		TOX-6	5E-2	10
65	Undrained Munition	MDB	Ton Container		MP3-002	1.1E-4	10
66	Undrained Munition	MDB	Ton Container		MP3-004	1.1E-4	10
67	Undrained Munition	MDB	Ton Container		MP4-001	1.1E-4	10
68	Undrained Munition	MDB	Ton Container		MP3-001	1.1E-4	10
69	Undrained Munition	MDB	Ton Container		MP3-003	1.1E-4	10
70	Undrained Munition	BSA	Ton Container		BSA-2	1E-2	10

TABLE 9-6 (Continued)

No.	Error Events	Area	Munition	Scenario	Sequence	Error Probability	EF
71	Ventilation System	TOX	Agent Tank		TOX-8	1E-4	10
72	Ventilation System	TOX	Agent Tank		TOX-2	1E-4	10
73	Ventilation System	TOX	Agent Tank		TOX-3	1E-4	10
74	Ventilation System	TOX	Agent Tank		TOX-5	1E-4	10
75	Ventilation System	MPB	Bulk Container		MPB-3B	1E-4	10
76	Ventilation System	MPB	Bulk Container		MPB-2B	1E-4	10
77	Ventilation System	ECR	Mine	POMVC 047	ECR-2DM	1E-4	10
78	Ventilation System	ECR	Mine		ECR-3DM	1E-4	10
79	Ventilation System	ECR	Mine		ECR-1DM	1E-4	10
80	Ventilation System	ECR	Mine		ECR-4DM	1E-4	10
81	Ventilation System	MPB	Bulk Containers		MPB-5B	1E-4	10
82	Ventilation System	MPB	Projectile		MPB-2DP	1E-4	10
83	Ventilation System	ECR	Projectile		ECR-1DP	1E-4	10
84	Ventilation System	ECR	Projectile	POPAC 047	ECR-2DP	1E-4	10
85	Ventilation System	MPB	Projectile		MPB-1DP	1E-4	10
86	Ventilation System	ECR	Projectile	POPAC 048	ECR-3DP	1E-4	10
87	Ventilation System	MPB	Projectile		MPB-3DP	1E-4	10
88	Ventilation System	ECR	Projectile		ECR-4DP	1E-4	10
89	Ventilation System	ECR	Rocket		ECR-2DR	1E-4	10
90	Ventilation System	ECR	Rocket	PORAC 047	ECR-5DR	1E-4	10
91	Ventilation System	ECR	Rocket	PORAC 048	ECR-6DR	1E-4	10
92	Ventilation System	ECR	Rocket		ECR-7DR	1E-4	10
93	Ventilation System	ECR	Rocket		ECR-1DR	1E-4	10
94	Ventilation System	ECR	Rocket		ECR-3DR	1E-4	10
95	Ventilation System	BSA	Ton Container		BSA-2	1E-4	10
96	Ventilation System	ECV	Ton Container		ECV-1	1E-4	10
97	Furnace Ventilation	FR	Ton Container		???	1E-2	10
98	Air Compressors	IA			???	1E-4	10

operators smoke), it is estimated that $1 \times 10^{-3} \times 3.3 \times 10^{-1} = 3.3 \times 10^{-4}$ is the probability of smoking initiating a fire.

Operators or maintainers could cause sparks any time they handle a weapon or use metal tools, which they are likely to do in any area of the plant. Except for the UPA, some sort of upset would probably have to have occurred for them to be handling munitions or using tools. The likelihood of their causing sparks in such a case is the same as that of their dropping a munition during handling. The estimated probability of dropping a single munition when it is hand-carried by a two-man crew dressed in DPE was estimated as 6×10^{-4} in the HRA for handling scenarios as described in Chapter 8.

9.2.2.4.2. <u>Fire Suppression</u>. When a fire occurs in the UPA, the control room, the UPS, the IEP, the communications room, or the TOX, an automatic fire-suppression system should come on. If the automatic system fails to start, the operators can initiate it from the control room. He does this in response to an annunciator alarming on the panel dedicated to fire alarms (an annunciator there always indicates fire somewhere in the plant). There are probably several other annunciators alarming at the same time; we assumed six for this analysis. Item 6 from Table 20-23 (Ref. 9-26), 5×10^{-3}, was used to estimate the likelihood of the operator's failing to initiate the failed automatic fire-suppression system.

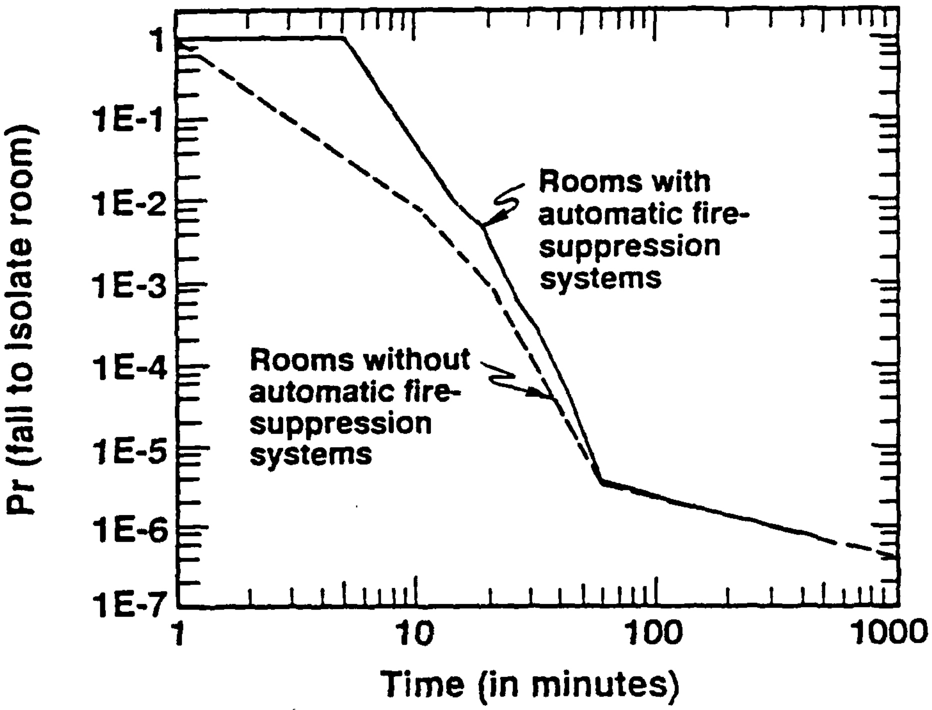
If the fire-suppression system still does not respond, or if the fire is in an area of the plant that has no automatic system, the next recourse for extinguishing the fire is to isolate the room where it is burning. The operators can do this by closing the exhaust dampers for the room in question. Again, they can do this from the control room. For this analysis, we assumed that the operators' training would emphasize room isolation as the best method of fire-fighting outside of the

use of automatic systems. Therefore, the problem is one of the operators' remembering that there is a viable solution to a fire.

The nominal diagnosis model from NUREG/CR-1278 (Ref. 9-26) was used as the basis to estimate the likelihood that the operators won't select room isolation. Since the "diagnosis" task here is fairly straightforward and since we have assumed that training will emphasize isolation as the action of choice, we used the lower bound of that curve to represent the case in which the fire is in a room without any automatic fire-suppression system.

If the fire does involve one of the rooms mentioned above, the operators will likely spend at least 5 min trying to start the failed automatic system. Since the diagnosis curve is time-based, 5 min of decision time is lost early in the accident. The modified curve accounting for this, along with the curve used for the rooms without fire-suppression systems, is shown in Fig. 9-1. The results of the analysis will show that the delay in diagnosing the need for isolation is more than compensated for by having an automatic system.

If the automatic fire-suppression system (if any) does not function and if room isolation is not achieved (or if it is not achieved in time), the operators' last resort is to enter the area with the fire and fight it with the hand-held fire extinguishers that are located throughout the plant. If it is an agent fire, if DPE protective clothing is necessary to enter the area, or if burstered munitions are in the area, it is assumed that the operators will not elect to try this option; they will not fight the fire at the site in any of these cases. If the fire is in an area they can enter wearing street clothes and masks and if burstered munitions are not present, it is estimated that there is a 5×10^{-2} probability that they will fail to try at-site fire fighting. This estimate is based on scientific judgment.



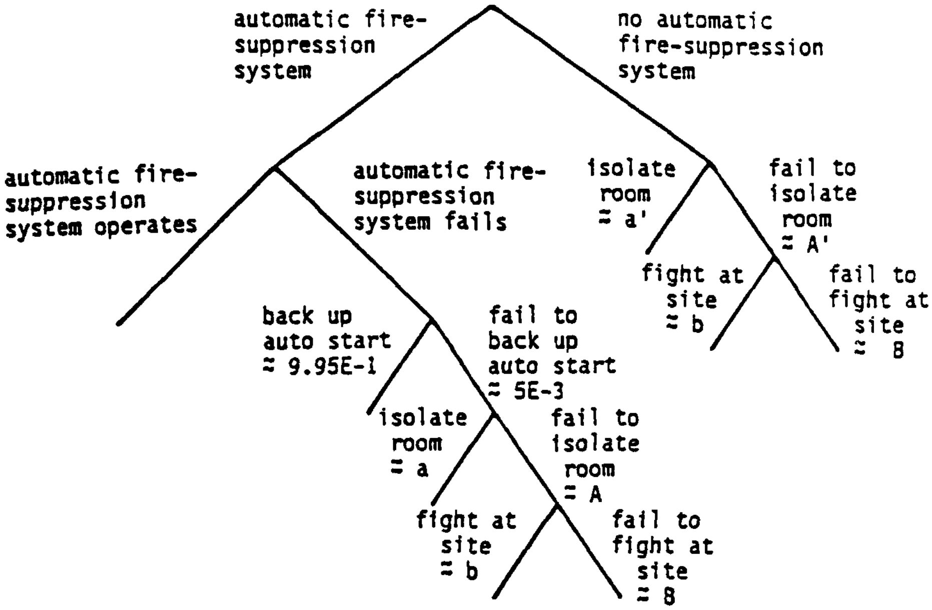
Time	Pr (fail to isolate by X mins)	
	With System	Without System
by 5 mins.	1.0	4E-2
by 10 mins.	4E-2	1E-2
by 15 mins.	1E-2	4E-3

Fig. 9-1. Probability of failure to isolate room by X min

For a complicated scenario such as this, THERP suggests the use of an HRA event tree. The HRA event tree for this fire-suppression model is shown in Fig. 9-2, and the results of quantifying it are shown in Table 9-7.

9.2.2.4.3. Conveyor Loading. In the UPA, operators in Level C protective clothing (masks worn) unload munitions and bulk containers from pallets and/or trucks and place them onto the conveyor system that then carries the munitions and containers through the process areas. Smaller munitions such as mines, projectiles, cartridges, and M55 rockets are lifted by hand (sometimes by two operators) and placed onto the conveyors. There are metering devices that ensure proper alignment of the rockets on the conveyor and allow only a single munition at a time to enter the ECV. When hand-loading the projectiles, operators could drop the munition in the UPA. The estimated probability of dropping a single munition when it is hand-carried by a two-man crew dressed in Level C protective clothing has been estimated as 3×10^{-4} in the HRA for handling scenarios.

The conveyor itself has 1/2-in. high guard rails that prevent a munition's falling off the conveyor. Even if the operators load the munition crookedly, the guard rails and the metering device will orient it properly as it passes into the ECV. The only other possible error involves their loading the munition backwards. Since we assume that the operators will usually pick up the same end of each munition (at least for a time), the likelihood of their standing in the wrong position--a necessary condition for loading the munitions backwards--is very low. It has been estimated to be an order of magnitude lower than the drop probability, or 3×10^{-5}. The likelihood that a munition is loaded improperly by the operators such that it could drop during loading or fall off the conveyor as a result of improper loading is the sum of these two error probabilities, or $3 \times 10^{-4} + 3 \times 10^{-5} = 3.3 \times 10-4$.



A = fail to isolate room having automatic suppression system

by 5 mins.	1.0
by 10 mins.	4E-2
by 15 mins.	1E-2

a = isolate room having automatic suppression system

by 5 mins.	0.0
by 10 mins.	9.6E-1
by 15 mins.	9.9E-1

A' = fail to isolate room not having automatic suppression system

by 5 mins.	4E-2
by 10 mins.	1E-2
by 15 mins.	4E-3

a' = isolate room not having automatic suppression system

by 5 mins.	9.6E-1
by 10 mins.	9.9E-1
by 15 mins.	9.96E-1

B = fail to fight fire at site when

agent fire, DPE, or burstered munitions	1.0
no agent fire, DPE, nor bursted munitions	5E-2

b = fight fire at site when

agent fire, DPE, or burstered munitions	0.0
no agent fire, DPE, nor bursted munitions	9.5E-1

Fig. 9-2. HRA event tree of fire suppression model

TABLE 9-7
THERP QUANTIFICATION OF FIRE-SUPPRESSION MODEL

Time After Onset of Fire (min)	Probability That Operators Fail to Suppress the Fire (DPE required or Burstered Munitions Present)			
	Agent Fire		No Agent Fire	
	Automatic Suppression System	No Automatic Suppression System	Automatic Suppression System	No Automatic Suppression System
5	5.0×10^{-3}	4.0×10^{-2}	2.5×10^{-4}	2.0×10^{-3}
10	2.0×10^{-4}	1.0×10^{-2}	1.0×10^{-5}	5.0×10^{-4}
15	5.0×10^{-6}	4.0×10^{-3}	2.5×10^{-6}	2.0×10^{-4}

Ton containers, spray tanks, and bombs are loaded onto the conveyor using a forklift lifting beam. The estimated probability of dropping a single bulk item when a two-man crew in Level C protective clothing use a forklift with a lifting beam was estimated as 1.5×10^{-5} in the HRA for handling scenarios. The only other credible errors are those of loading the containers crookedly (a no-cost error given the guard rails) or backwards. Backwards loading is most likely with a ton container since its exterior profile shows no obvious fore or aft indication (except for location of the plugs). Again, the operators have separate, assigned duties during loading. Since the ton containers should be guided by one operator while the other operator drives the forklift, the likelihood of its being improperly loaded is estimated to be an order of magnitude lower than the drop probability, or 1.5×10^{-6}. The likelihood that any kind of bulk container is loaded improperly by the operators is the sum of these two error probabilities, or $1 \times 10^{-5} + 1 \times 10^{-6} = 1.65 \times 10^{-5}$.

9.2.2.4.4. Munition Counting. When munitions are unloaded in the UPA, the packing material is sent to the Dunnage Incinerator (DUN). If a munition is left in the packing material (if it is not unpacked), it will be sent as-is to the DUN, also. The operators must keep track of the pallets and barrels passing through the UPA to ensure that they are emptied before being disposed of. All pallets are unloaded completely before beginning the next pallet-unloading operation. In other words, two pallets are never partially unloaded because of their being unpacked simultaneously. Since the pallet layers must be removed to access munitions on the next layer down, it is not likely that operators will miss a palletized, unpacked munition. Also, the pallet itself does not obscure the individual munitions from view even before it has been removed. The likelihood that an operator will fail to unpack a pallet completely and send the unpacked munition to the DUN along with the dismantled pallet is negligible.

Mines are packed three to a barrel; their fuzes are packed separately but in the same barrel. There are six barrels on a pallet. Once the pallet has been dismantled, the barrels themselves must be unpacked. The barrels are inverted inside a glove box one at a time, then lifted off of the mines and the packing material. Once the barrel has been emptied, it is used to hold the discarded packing material for the trip to the DUN. For a mine to enter the DUN along with the packing material, it would have to be placed in the barrel instead of on the conveyor. Munition accountability with respect to the number processed will be checked before the dunnage is disposed of; this provides a measure of recovery should this highly unlikely event occur. The probability of a mine being fed to the DUN along with its packing material is assumed to be negligible.

9.2.2.4.5. Tank Overfill. When draining a bulk-agent container, the agent is transferred to an agent tank in the Toxic Cubicle (TOX). When the agent tank's capacity is reached, the process-control system should automatically halt the transfer. If the high-level sensor on the tank fails or if some other failure occurs such that the transfer is not halted, the operator who initiated the transfer can halt it manually before the tank spills over.

It should be stated in the plant's administrative-control policies (and even in the process-control logic) that a bulk container should not be drained unless its entire contents can be accepted by a single agent tank. Of the two agent tanks in the TOX, the operators could have selected (and the process-control logic could have defaulted to allow) the wrong tank to receive the agent from a bulk container. If this wrong tank has insufficient capacity to accommodate the contents of the container, TOX tank level will approach and then exceed its maximum sometime during transfer. The probability of a selection error when dealing with displays with clearly delineated mimic lines is estimated to be 5×10^{-4} (Ref. 9-26, Table 20-9, item 1). Since this error has to occur in conjunction with a process-control failure (the probability of

which is estimated to be 1×10^{-3}), the likelihood that the wrong tank will be selected to receive the agent is 5×10^{-7}.

Assuming that agent is being transferred to a too-full tank, a sensor should halt the transfer at the tank's high-level setpoint. If the sensor fails, the operator (who should be monitoring the transfer intermittently) might notice the tank's high level and halt the transfer manually before a spill occurs. A typical transfer operation takes about 30 min; it is not assumed that the operator will watch the levels in the bulk container and the TOX tank for that whole period (although it is assumed that he will monitor both levels at some point since he initiated the transfer). Rather, it is assumed that he will initiate the transfer and then leave to complete other tasks while it is going on; it is also assumed that he will return to view the monitor screen periodically during the transfer to check its progress.

The estimated probability of his not noticing that the level of the TOX tank is dangerously high during the transfer operation is based on the estimated probability of an error made in reading quantitative information from an analog meter, 3×10^{-3} (Ref. 9-26, Table 20-10, item 1). The lower bound of 1×10^{-3} is used for this case to reflect better-quality reading characteristics associated with CRT analog displays. If the operator returns several times during the transfer to check the level of the TOX tank, the memory of his first reading will influence his perception of subsequent readings, so they were considered a perceptual unit. Both error probabilities are summed to estimate the total human-error contribution to this scenario. This means that $5 \times 10^{-7} + 1 \times 10^{-3} = 1 \times 10^{-3}$.

9.2.2.4.6. Sump Pump Operation. When there has been a spill in the TOX, the sump pump provides some level of mitigation. If the sump pump fails to operate following a spill, there is still a chance that the operators could start it manually from the control room. Since the spill in the TOX has already occurred when the sump pump fails, there

are probably several annunciators alarming when the sump pump alarm goes off. Assuming there are ten annunciators competing for the operator's attention, 5×10^{-2} (Ref. 9-26, Table 20-23, item 10) is the probability that he will fail to respond to the sump pump alarm.

9.2.2.4.7. Undrained Munition. There is some chance that an undrained ton container will reach the MPF, where it presents a considerable hazard. There are two points at which the operator might notice this and intervene to prevent its introduction into the MPF. The first of these is in the MPB as the container is being drained. The operator should have initiated the drain operation and should be watching for some indication that it is, in fact, taking place.

The second potential for operator intervention comes as the container leaves the BSA and is weighed before being transferred to the MPF. The operator should check the reading at the weigh station before allowing the container to continue to the MPF. The likelihood that the operator does not watch an operation that he is supposed to monitor on the CRT screen and/or the CCTV is assumed to be equivalent to his not following/using a set of written procedures. The error probability for his failing to monitor the screen(s) is 1×10^{-2}, taken from Ref. 9-26, Table 20-6, item 3. This is used for his failing to monitor the drain operation in the MDB before the container is transported to the BSA and also for his failing to check the weight of the container as it leaves the BSA.

If the operator checks the container's weight, there is a chance that he will misread the weight on the CRT display. The probability of a misreading error when using a CART analog display is 1×10^{-3} (Ref. 9-26, Table 20-10, item 1, lower bound). The likelihood that the operator in neither case acts to prevent an undrained container's entering the MPF is calculated as $(1 \times 10^{-2} \times 1 \times 10^{-2}) + 1 \times 10^{-3} = 1.1 \times 10^{-3}$.

9.2.2.4.8. Ventilation System. Any time there is a ventilation system failure, there is some chance that the operators could effect recovery. For areas outside the furnace rooms, the operators should shut off the air supply fans within an hour of ventilation system failure. There is no direct indication that this is the needed action, so some diagnosis is involved. Using a standard diagnosis curve, the likelihood of their having failed to shut off the air supply fans by the end of an hour is estimated as 1×10^{-4} using Fig. 12-4 from NUREG/CR-1278 (Ref. 9-26)

9.2.2.4.9. Furnace Ventilation. For ventilation system failures involving the furnace rooms, the scenario is somewhat different. One train should be in service at all times. If that ventilation train fails, the operators can valve in an alternate train. This involves closing the dampers to the failed system, opening the dampers and headers to the alternate system, and starting up the alternate system. The primary ventilation system is assumed to fail at least 10 min following an initiator involving furnace shutdown; once it has failed, the operator has about 10 more minutes to complete the transfer to avoid serious consequences.

Since the ventilation system failure occurs 10 min after the furnace shutdown, the two failures do not occur "closely in time". Moreover, different operators are dedicated to monitoring the furnace and the ventilation systems. Therefore, the first-event diagnosis model (Ref. 9-26, Table 20-3, item 1) was chosen to model this event. Since the furnace shutdown is likely to lead to ventilation system failure, the operators may expect to have to deal with that problem. Because of their expectation, the lower bound of the nominal diagnosis model value, or 1×10^{-2}, was used.

9.2.2.4.10. Air Compressors. Some sequences assumed a reduced capacity of the primary plant-air and instrument-air compressor because of a downstream blockage. Since the blockage does not involve the

compressor itself, no trouble alarm associated with it will sound. Instead, a low-pressure alarm for downstream will sound at some time, after which there is a 15-min period before reserve-air inventory is depleted.

The non-occurring trouble alarm would have been sufficient to cause automatic transfer to the standby compressor; since it did not alarm, the transfer must be initiated by an operator sometime in that 15-min interval. This depends on his noticing the low-pressure alarm since an operator's recognition of an annunciator means that he will respond to that annunciator. It is assumed that there would have been no other shutdowns (nor their associated alarms) for at least 15 min before the low-pressure alarm sounds, so the error estimate listed as item 1 in Ref. 9-26, Table 20-23, was used.

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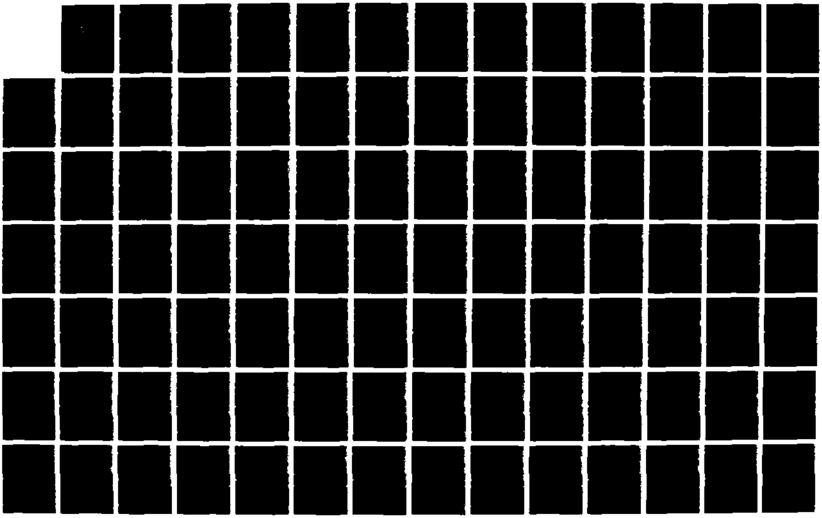

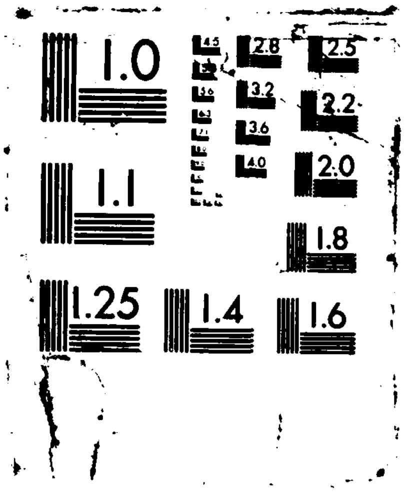

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5

10. AGENT RELEASE CHARACTERIZATION

Section 10.1 describes the approach used in this study for analyzing the agent release for the various accident conditions. Application of the approach to the accident sequences analyzed in the onsite disposal phases is discussed in Section 10.2.

The consequences of an agent release event are strongly dependent on agent type, amount of agent release, and the mode and duration of the release. Agent dispersion and subsequent effects will be calculated in a separate study using a computer program called D2PC (Ref. 10-1) that embodies an analytical model for calculating agent dispersion under different meteorological conditions. Feedback from these consequence calculations helped to guide the release characterization.

10.1. RELEASE ANALYSIS APPROACH AND BASES

10.1.1. Approach

The approach formulaton was aided by a systematic review of the mechanisms involved in expelling agent from its normal confinement. The first result of the systematic review was to divide the accident sequences into two groups: (1) those that occur while the agent is still present in the munitions and (2) those that occur after the agent has been separated from the munition. The first group is associated with the activities of storage, handling, and transportation, while the latter group is associated with the activities of plant operations. For the latter group, the analyses performed by Arthur D. Little for the M55 rockets (Refs. 10-2 through 10-6) were partially applicable, and similar assumptions as appropriate were made for this analysis. Additional calculations were performed in this study to determine the quantity of

agent released to the environment for plant operation accidents involving munitions other than the M55 rockets.

For the accident sequences that involve agent still confined in the munition, the agent release is dependent on the munition's mechanical and thermal failure thresholds, and the behavior of the explosives and propellants during the accident sequences. These are discussed in the following sections. Once it was determined that the agent could be released from its normal confinement, calculations were performed to determine the amount of agent released and the possible paths by which the agent could enter the atmosphere.

10.1.2. Mechanical Failure Release

Munition failures result when sufficient forces are generated during accidents. A discussion of the munition failure thresholds is given in Appendix F. The failure thresholds of interest are:

1. Mechanical failure of the agent containment due to impact, crush or puncture.
2. Detonations initiated by impact or fire.
3. Thermally induced hydraulic rupture of the agent containment.

10.1.2.1. Impact Failure. The threshold for impact failure is given in terms of velocity of impact against a nonyielding object, or the equivalent drop height. When the impact failure threshold is reached, it is assumed that the onset of failure begins. In the case of an accident involving more than one munition, e.g., a pallet drop or a truck collision, every munition does not experience the effect of impacting a nonyielding surface. At the threshold point, it is assumed that at least one munition has experienced failure. It was further assumed that the number of munitions that experience failure is a function of the kinetic energy involved in the accident. For munitions in a transportation package, the failure threshold for both the package and the munition must be exceeded in order to cause an agent release.

The impact velocity required to initiate failure varies from 35 mph for rockets (drop height of 40 ft) to 50 mph for projectiles (drop height of 120 ft). The expected impact velocity (or drop height) for some accidents is:

Accident Type	Impact Velocity of Drop Height
Pallet drop during handling	6 ft
Forklift collision	5 mph
Truck accident onsite	10 to 25 mph (administrative control is assumed to be 10 mph)

In view of the above, failure due to impact is not considered to be a significant contribution for handling accidents and onsite truck transportation accidents, i.e., other failure mechanisms dominate.

10.1.2.2. Crush Failure. Crush forces are static forces completely independent of velocity. Crush forces may arise from a vehicle overturn or from a building collapse due to an earthquake.

Crush thresholds are defined for a single munition for a pallet of munitions and for the transportation package when transportion is involved. When the crush threshold for pallets is exceeded, it was conservatively assumed that all munitions in the pallet will fail.

A linear relationship for the number of units that would fail due to crush was assumed as follows:

$$n = \frac{F}{F_o} \quad , \tag{10-1}$$

where F = crush force available in the accident,

F_o = crush force threshold for the palletized munition.

At n = 1, all the munitions in one pallet have failed. The available force in an accident can be the weight of a vehicle, the weight of a building collapse, or the weight of any large object that can fall on the munitions. For those accidents involving a transportation package, the crush force available must exceed the threshold for failing both the package and the munition.

The accident sequences that are capable of generating forces sufficiently high to produce crush involve transportation and storage where many pallets may be involved in the accident. Thus, it is possible that more than one pallet can fail. For example, the crush threshold for a rocket pallet containing 15 rockets is 43,400 lb. If the weight of an object is 100,000 lb, Eq. 10-1 predicts a failure quantity of 2.3. This corresponds to 2.3 pallets, or about 34 rockets being crushed. If the available crush force is less than the failure threshold for a single munition, then naturally, no munitions fail.

Equation 10-1 is conservative because it assumes that the total available load arising from an accident is concentrated in the most efficient way to crush the munitions. If the load was uniformly distributed over many pallets, fewer or no failures would occur.

10.1.2.3. Puncture Failure. The puncture threshold is defined in terms of the ratio of velocity to radius of curvature assuming the munition (or pallet) impacts an unyielding slender object or probe. Generally, the failure threshold for puncture is the lowest of the three mechanical failure thresholds. The number of failures that can occur in an accident is dependent on the number of probes present. If the puncture failure threshold is exceeded, it is assumed that one probe will fail one munition.

10.1.2.4. Liquid Spills and Evaporation. Once mechanical failure occurs, the munition agent inventory may be able to spill out on the ground or water. For fork tine punctures, the puncture is assumed to

consist of a 3-in. diameter hole just below the munition centerline. The amount and time of spill is calculated to be that which can drain by gravity out of the hole. Impact, crush and probe punctures are assumed to result in the spill of the entire munitions inventory.

If the spill occurs outdoors, during handling or transport, the release analysis ends with the determination of the type and mass of liquid agent spilled and type of surface where the spill occurs. This information is sufficient input for calculation of atmospheric dispersion by the D2PC computer program. All liquid spills during handling or ground transport are assumed to occur on a hard, flat impervious surface such as level concrete or asphalt. The evaporation of the spill is calculated by the D2PC program (Ref. 10-1) by calculating the maximum puddle area and the corresponding evaporation rate.

If the spill occurs indoors, the release analysis in this report extends to the time dependent rates of evaporation. In general, the D2PC program was applied to calculate the evaporation rate based on the type and mass of agent spill and considering any confinement of the liquid puddle or pool. The D2PC general equation for evaporation of a spill over a floor area corresponding to a liquid pool depth of 1/32 in. relates the time t to evaporate the entire spill inventory M (pounds) in terms of a power function of M and two coefficients a and b. The equation is

$$t = aM^b \quad , \tag{10-2}$$

where t = time in thousands of minutes,

a, b = constant for agent GB ($a = 0.79$, $b = 0.253$),

a, b = functions of M for agents H and VX.

The area (ft^2) corresponding to the spill M (lb) and pool thickness 1/32 in. is 5.91 times M. For restricted pool areas, the equation must be modified. This equation and coefficients a and b are based on data from the Army derived from the computer program D2PC output.

For a given accident sequence the spill will generally not evaporate to completion because human intervention will mitigate the spill by covering it with foam or some other means. In such a case, an evaporation rate is calculated and applied until the time estimated for mitigation or cleanup of the spill.

From Eq. 10-2, the hourly evaporation rate is

$$m_{ev} = \frac{1}{a} M^{1-b} \frac{60 \text{ min}}{10^3 \text{ min}} \quad , \qquad (10\text{-}3)$$

where m_{ev} has units of lb/h. This equation applies whenever the 1/32-in. deep spill pool area, which from the agent density is about 6 ft^2 for each lb of spill, is smaller than the actual confined pool area (floor or sump). Some buildings contain floors which slope to sumps, as in the following:

Building Area	Sump Size (ft)
UPA	2 x 2 x 2
TOX cubicle	4 x 5 x 3.5
MHI	2 x 3 x 4
Warehouse	None
Storage igloo	None

Where a sump is present, the following procedure is used to calculate evaporation. Initially, the spill is assumed to wet the entire sloped floor area. Thus, Eq. 10-3 issued for a 10 min time period without modification for pool area, unless the 1/32-in. deep pool area is larger than the actual floor area. Modification consists of limiting

M in Eq. 10-3 to the mass of a 1/32-in. layer of agent over the actual floor area. After 10 min, the evaporation rate is assumed to be limited by the sump horizontal cross sectional area until the assumed mitigation/cleanup time when it drops to zero. Such limitation amounts to modifying M in Eq. 10-3 to the mass of a 1/32-in. layer in the sump.

A special case is the spill of a ton container in the MDB where a single UPA sump is too small to hold the entire inventory. In this case the overflow area is calculated based on the volume of agent in a TC and the floor slope (1/4 in. rise per linear foot).

10.1.3. Detonations

The burstered munitions incorporate proven design features to preclude accidental detonation during routine handling and transportation. The impact threshold for initiating detonation, approximately 160 mph (see discussion in Appendix F), is well above the potential impact velocity for all accidents except an aircraft crash. When a munition is subjected to an impact velocity greater than the detonation threshold velocity, there is still a low probability of detonation, but it is possible. Data does not exist to develop a meaningful relationship for predicting the number of detonations that could occur given an aircraft crash into a munitions storage area or transport vehicle. This rationale is that, given a stack of munitions pallets in storage or in a transport vehicle, the munitions in the first row would absorb most of the impact energy. These munitions could detonate. The others would then be subjected to the energy of the detonations, as well as part of the energy of the aircraft crash. It is known that the detonations do not propagate, but it is assumed that many of them would rupture. This logic was applied to all the aircraft crash scenarios and a general result was reached. The conservative estimate is that:

1. Fifteen percent of the munitions involved in the crash detonate.

2. Seventy percent of the rupture and release their agent content.

3. Fifteen percent are scattered but remain intact.

For impacts of burstered munitions in pallets, if a single munition detonation occurs it is assumed to rupture each surrounding munition in the pallet. A centrally located munition, which has the largest number of surrounding units, is conservatively assumed to be the one which detonates, even though it is less likely to detonate at this location than at the end. For projectiles, cartridges, and mortars, the number of adjacent munitions ruptured is five.

For rockets and mines only, the detonation of more than one munition was calculated to be credible for certain pallet impacts. In such cases, two rockets detonate, rupturing 13 adjacent rockets. Or, three mines detonate rupturing 15 adjacent munitions.

10.1.4. Fire Release

Munitions subject to fire can fail due to thermally initiated detonations or due to hydraulic rupture. It is assumed that fires in direct contact with burstered munitions will be left unattended and allowed to burn until all combustible materials are consumed. Thus, bursters will detonate. Some neighboring munitions will fail due to the detonation. The failed munitions will spill combustible agent which will further fuel the fire. The fire will spread, leading to more detonations, and so on.

Tests at GA on 4.2-in. mortar projectiles and 8-in. projectiles showed that a detonation of a munition in a close packed array will cause the munitions adjacent to the detonated munition to break and spill their agent (Ref. 10-7). Other munitions not in direct view of

the detonated munition were disheveled, but remained intact. Thus, one detonation is not sufficient to break all the munitions involved in the accident. A chain reaction must take place. The bursters in the neighboring munitions broken by a detonation will be subjected to more rapid heating than those of an intact munition. These bursters will detonate at a critical temperature, but it is assumed that detonation of a drained munition will not contribute to the agent release.

Based on the test results described above, it is inferred that all munitions in direct view of a munition detonation would be broken. In a rectangular array, typical for the munition storage configurations, this results in an agent release fraction of 1/9 due to detonation and 8/9 as a liquid spill. An irregular array, such as would exist after the first detonation, could result in a larger release fraction due to detonations. Therefore, it is assumed that 25% of the agent release is due to detonations for sequences involving fire and detonations.

It is assumed that fires involving nonburstered munitions will always be fought. However, when an accident involves a large fire, the first priority may be to contain the fire and prevent its spreading into unaffected areas. For conservatism, a large fire involving nonburstered munitions was treated as in the case for burstered munitions, i.e., all combustible materials involved in the accident are consumed. Whether burstered or nonburstered munitions are involved, large fires were assumed to be confined to one building or one truck, as appropriate.

Agent that is burned is basically destroyed, but the destruction is usually incomplete. A previous analysis (Ref. 10-8) indicated that the recovery of undecomposed agent from fires is 2.5% for GB and 0.2% for VX. The analysis was based on tests at Dugway Proving Ground (Refs. 10-9 and 10-10) in which a mock-up igloo with 11 pallets of rockets containing GB was allowed to burn to completion. The unburned GB vapor was measured by a grid of detectors surrounding the fire at 30 m distance and extending 30 m high. Actual test measurements were made

for GB, and the results for VX were derived by extrapolation based on the boiling temperature, thermal decomposition temperature and volatility of VX relative to GB.

Although the above references provide a quantitative data point on the behavior of agent in a large fire involving an igloo or a transport vehicle, there are several reasons to increase the predicted agent release fraction for fires. These are:

1. The analytical procedure for detecting agent during the test yielded small quantities of agent distributed over a large number of detectors. The samples were analyzed by the dianisidine-peroxide method. The sensitivity of these measurements is expected to be marginal considering the short time available for sampling the gas cloud as it passed through the detection grid. Therefore, it is possible that a significant amount of agent vapor was not detected during the test.

2. The rockets contain a large amount of propellant, which in turn contains its own oxidizer. The propellant burns very quickly and tends to produce a hot fire, even when the fire is limited by the amount of oxygen present. Fires involving other munitions may burn slower and at a lower temperature, which would promote a higher fraction of undestroyed agent.

3. In one simulated test of an igloo fire (Ref. 10-10) four rockets were launched out of the igloo. One of them traveled 1300 ft away from the igloo. None of them detonated upon impact, but they all broke open and spilled agent onto the ground. When one adds the liquid spill of the four rockets that escaped from the igloo to the 2-1/2% agent vapor recovered, the total agent release from the event is 4.9%.

4. The analytical extrapolation to determine the recovery fraction for VX is not documented. Further, the uncertainty of an extrapolation in a complex thermal-chemical rate process is considered to be large. Although the chemical properties of VX and GB suggest that the recovery fraction for VX should be much less than GB, the conclusion that the recovery of VX would be 6% times the recovery of GB as stated in Ref. 10-10 is viewed with skepticism. Therefore, a more conservative value of 25% was assumed for the recovery factor of VX versus GB. Similarly, the chemical properties of HD suggest that an analytical extrapolation for the recovery of HD would also be less than GB, but greater than VX. Therefore, a value of 50% was assumed for the recovery factor of HD versus GB.

In view of the above discussion, the release fraction for unburned agent GB vapor in all fire scenarios was assumed to be 10%. This provides a factor of two over the 4.9% combined liquid plus vapor measured in the test to allow for uncertainties in the test measurements and uncertainties in the liquid agent that escapes the fire. The corresponding release fractions for HD and VX are assumed to be 5% and 2-1/2%, respectively. These release fractions are not considered as over conservatism. The main conservatism arises from the assumption that all the agent inventory is involved in the fire, and no credit is taken for the possibility that the fire might be extinguished before all combustible materials are consumed.

10.1.5. Release Duration

The accident durations assumed for this risk analysis were chosen to conservatively define a time for terminating most accidents identified in this analysis. In the sequences involving liquid spills, the accident is terminated when the decontamination team has successfully terminated evaporation of agent vapor into the atmosphere. Army experience in handling and moving chemical munitions indicates that may of the

agent spills could be cleaned up much quicker than the times assumed herein. However, since many accidents are rate events and have not occurred in the Army experience to date, conservative times for the accident durations have been applied.

The agent release for an evaporative spill is directly proportional to the release duration. Therefore, to be conservative, the release durations were estimated on the high side. The release durations assumed are:

1. For agent spills occurring during handling or demilitarization operations caused by human or equipment malfunction, the release duration was assumed to be 1 h.

2. For agent spills involving human or mechanical error during onsite transportation, it was assumed that the accident could not be terminated as quickly as the above. Therefore, the release duration was assumed to be 2 h.

3. For agent release in the MDB following an accidental detonation outside the ECR, but with no fire, the release duration was assumed to be 2 h.

4. For agent spills arising from an aircraft crash with no fire, the release duration was assumed to be 4 h.

5. For severe external events, e.g., earthquake, tornado, airplane crash, the evaporation time was assumed to be 6 h.

Table 10-1 lists the times assumed for agent release for the accident scenarios involving fire and/or detonations. Plant operations accident scenarios are not included in the table because these accidents are mitigated by engineered safeguard features and are not covered by the discussion that follows.

TABLE 10-1
AGENT RELEASE DURATION FOR ACCIDENTS INVOLVING FIRE AND DETONATION

Event	Agent Release Duration (min)	Type of Event
Fire only - no detonations	10	Handling vehicle collision
	60	Aircraft crash, truck collision/overturn, meteorite strike, earthquake
Fire with detonation	20	Aircraft crash, truck collision, earthquake
	60	Meteorite strike
Detonations only	Instantaneous	Aircraft crash

The approach to deriving the assumed release durations was to group the accident scenarios with fire or detonations into sets with similar characteristics, then estimate a release time ranging from 10 min to 1 h. For accidents involving a large fire, it was assumed that all of the agent present ultimately becomes consumed or released as vapor. The conservative approach for these cases is to assume a shorter duration than expected because a given release to the atmosphere is more lethal when distributed over a shorter time interval. Factors which influence the choice of time periods are discussed below.

There are three possible combinations of scenarios involving fire and/or detonations:

1. Detonations only.
2. Fire and detonations.
3. Fire only.

10.1.5.1. Detonations Only. The scenarios that fall into this category involve a high velocity impact, such as a spurious detonation arising from undue forces that are part of the accident scenario, e.g., dropping a pallet. It is known that the detonations do not propagate. Therefore, the release from detonations is assumed to occur instantaneously.

10.1.5.2. Fire and Detonations. These events are associated with storage and transportation accidents. For some events, there is a source ofexternal fuel, e.g., fuel from a truck. In these scenarios, the detonations are propagated by the fire, and concurrently the detonations allow additional munition failures that further fuel the fire. The overall result is a violent conflagration. The total duration of the accident may be an hour or more; however, for conservatism, the duration of the agent release is assumed to be 20 min. The scenarios not included in the 20-min assumption involve a meteorite strike into a storage igloo or into a temporary storage area. In this case, there is no source of external fuel, although the scenario does assume that fire

is initiated, and detonations are propagated by the fire until all combustible materials are consumed. Because the meteorite fire starts out relatively localized and without external fuel, the release duration for the meteorite strike is assumed to be 1 h.

10.1.5.3. Fire Only. Events involving fire only occur in some handling, storage, and transportation accidents. For events associated with onsite handling the amount of agent involved in the fire is relatively small. The exposed agent is allowed to burn to completion, and the release duration is assumed to be 10 min. The accidents in this group associated with transportation involve a moderate source of external fuel. In addition, these events involve large quantities of agent, but they do not involve burstered munitions. Therefore, these accidents present a less difficult situation to control than the corresponding case when burstered munitions are present. The agent release duration for these events was assumed to be 1 h.

10.2. APPLICATION TO ACCIDENT SEQUENCES

This section illustrates the application of the release methodology to determine agent releases for the specific accident sequences for each phase of the demilitarization process. It is not intended to encompass all sequences. Appendix I presents the agent releases for all sequences.

10.2.1. Handling

The procedure for analyzing agent releases during handling accidents was to first group the accident sequences according to agent release conditions or types of release. For example, there were a number of sequences resulting in liquid spill outdoors (HC5, HC7, HC10, HF1, HF7, and HC8). Table 10-2 shows the grouping results for all handling sequences. There were the following types of releases to be assessed:

1. Single munition rupture and spill outdoors.
2. Single munition rupture and evaporation indoors (in MDB, MHI, LPF, or storage igloo) or inside the package.
3. Burning of ruptured single munition spill outdoors.
4. Impact detonation of single munitions indoors.
5. Impact detonation and spill of munitions outdoors.
6. Impact detonation and spill of munitions indoors.
7. Fire and thermal detonation of munitions.

The agent inventory data for onsite and offsite transport containers is summarized in Table 10-3. Indoor spills are assumed to be mitigated within 1 h, so that evaporation lasts for that long. Failure of the building ventilation system is a part of the definitions of these

TABLE 10-2
GROUPING OF HANDLING SEQUENCES ACCORDING TO
AGENT RELEASE CHARACTERISTICS

Type of Release	Single Munitions Fails	Multiple Munitions[a]
Puncture/crash		
Liquid spill		
Outdoors[b]	H05, H07, HF1, HF7	None
Evaporation		
In MDB	HF2, HF8, HF9, HF10	None
In package	H014, HF4	None
In storage igloo	H01, H03, H04	None
Burning of agent spill		
Outdoors	H02, H06, HF3	None
Impact detonation and spill (if more than one) (no fire)		
Outdoors[b]	None	H022, H024, HF11, HF14
Indoors	HF12	H011, H012, HF13
Fire and thermal detonation	None	H026, HF5

[a]Involves inventory of one pallet.

[b]Outdoor spill release given in pounds of liquid, evaporation calculated by Mitre.

TABLE 10-3
INVENTORY DATA FOR ONSITE TRANSPORT CONTAINERS

Munition/Agent Type	Munition Inventory (lb)	No. Munitions Per Pallet or ONC
Bomb		
GB	220.0	2
Mortar		
H	6.0	48
105 cartridge		
GB	1.6	24
H	3.2	24
Ton container		
GB	1500.0	1
H	1700.0	1
VX	1600.0	1
Mine		
VX	10.5	36
155 projectile		
GB	6.5	8
H	11.7	8
VX	6.0	8
8-in. projectile		
GB	14.5	6
VX	14.5	6
Rocket		
GB	10.7	15
VX	10.0	15
Spray tank		
VX	1356.0	1

sequences. The results for each of the above types of releases are summarized in Table 10-4.

10.2.2. <u>Warehouse Storage Release During Earthquakes</u>

There are three sites with stored, nonburstered munitions in warehouses. These are:

1. UMDA - ton containers with agent HD stored in two warehouses.
2. NAAP - ton containers with agent VX stored in one warehouse.
3. TEAD - spray tanks with agent VX stored in two warehouses.

Only spray tanks and ton containers are stored in warehouses, none of which contain agent GB. Based on their impact characteristics, the ton containers are predicted to be able to be crushed or breached by the kinetic energy of a falling I-beam if the warehouse structure is damaged. Each I-beam has sufficient energy to crush one ton container but not two. Thus, the *maximum number of ton containers* crushed per warehouse is five, since there are that many I-beams in the warehouse roof. For similar reasons, the maximum number punctured is taken to be five per warehouse.

Spray tanks are stored in overpacks and, based on structural calculations, are not expected to be breached by the falling I-beams. Consequently, the mechanical breaching of spray tanks due to an earthquake is not considered a credible event. If a fire lasts beyond 30 min, spray tanks may fail due to the unsuppressed fire. Thus, for spray tanks, only one type of release is considered, namely burning of one or two warehouse inventories due to fire beyond 30 min. The release fraction due to unburnt VX agent in this case is 2.5%, as in other accident scenarios.

TABLE 10-4
AGENT RELEASES (POUNDS) FOR HANDLING SEQUENCES

Sequences	Release Mechanism	No. Munitions	Bomb GB	4.2-in. Mortar H	105 mm Cartridge GB	105 mm Cartridge H	Ton Containers GB	Ton Containers H	Ton Containers VX
HO2, HO6, HF3	Burn of spill	1	22	0.3	0.16	0.16	150	85	40
HO5, HO7, HF1, HF7	Outdoor spill(a) (pounds of liquid)	1	220	6.0	1.6	3.2	1500	1700	1600
HO11, HO12, HF13 (Impact detonation)	Detonation release	M	NA	1.50	0.40	0.80	NA	NA	NA
	10 min floor evaporation	N	NA	1×10^{-3}	0.09	5×10^{-4}	NA	NA	NA
	Sump evaporation	N	NA	3×10^{-4}	0.07	3×10^{-4}	NA	NA	NA
	Total evaporation		NA	ϵ	0.16	ϵ	NA	NA	NA
HO14, HF4	Package evaporation	1	0.22	0.01	0.22	0.01	0.22	0.01	ϵ
HF12	Detonation release (no fire)	1	NA	1.50	0.40	0.80	NA	NA	NA
HO26, HF5 (1 pallet - thermal failure)	Detonation release	P	NA	72	9.6	19.2	NA	NA	NA
	Fire release	P	44	11	2.9	2.9	150	85	40
	Total release		44	83	12.5	22.1	150	85	40
HF2, HF8, HF9, HF10	1 min evaporation inside MDB	1	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ
HO22, HO24, HF11, HF14	Impact detonation	M	NA	1.5	0.40	0.80	NA	NA	NA
	Outdoor spill(a)	N	NA	30	8.0	16.0	NA	NA	NA
HO1, HO3, HO4 (Spill in storage igloo)	Floor evaporation (no sump)	1	4.26	ϵ	0.10	ϵ	6.40	ϵ	ϵ

TABLE 10-4 (Continued)

Sequences	Release Mechanism	Mine	155-mm Projectile			8-in. Projectile		Rocket		ST
		VX	GB	H	VX	GB	VX	GB	VX	VX
HO2, HO6, HF3	Burn of spill	0.26	0.65	0.59	0.15	1.45	0.36	1.07	0.25	33.9
HO5, HO7, HF1, HF7	Outdoor spill(a)	10.5	6.5	11.7	6.0	14.5	14.5	10.7	10.0	1356
HO11, HO12, HF13	Detonation release	7.88	1.63	2.93	1.50	3.63	3.63	5.35	5.0	NA
(Impact deonta-	10 min floor evaporation	4×10^{-5}	0.22	4×10^{-4}	8×10^{-6}	0.10	4×10^{-6}	0.97	ϵ	NA
tion)	Sump evaporation	2×10^{-6}	0.07	3×10^{-4}	2×10^{-6}	0.07	2×10^{-6}	0.07	ϵ	NA
	Total evaporation	ϵ	0.29	ϵ	ϵ	0.17	ϵ	1.04	ϵ	NA
HO14, HF4	Package evaporation	ϵ	0.22	0.01	ϵ	0.22	ϵ	0.22	ϵ	ϵ
HF12	Detonation release (no fire)	2.63	1.63	2.93	1.50	3.63	3.63	2.68	2.50	NA
HO26, HF6	Detonation release	95	13.0	23.4	12.0	21.8	21.8	40.1	37.5	NA
(1 pallet -	Fire release	7	3.9	3.5	0.9	6.5	1.6	16.1	2.8	34
thermal failure)	Total release	102	16.9	26.9	12.9	28.3	23.4	56.2	40.3	34
HF2, HF8, HF9, HF10	1 min evaporation inside MDB	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ	ϵ
HO22, HO23, HO24,	Impact detonation	7.88	1.63	293	1.50	3.63	3.63	5.35	5.0	NA
HF11, HF14	Outdoor spill(a)	2363	32.5	58.5	30.0	72.5	72.5	139	130	NA
HO1, HO3, HO4 (Spill in storage igloo)	Floor evaporation (no sump)	ϵ	0.24	ϵ	ϵ	0.56	ϵ	0.45	ϵ	ϵ

(a)Notes: Outdoor spills are in terms of pound of liquid, C = number of pallets in offsite container, P = number of munitions in pallet, ϵ = negligible, M = number of munitions detonating, N = number of munitions rupturing, NA = not applicable.

For mines, M = 3, N = 15, C = 3, and P = 36. For rockets, M = 2, N = 13, C = 4, and P=15. For all others, M = 1 and N=5.

For ton containers, three release types were considered:

1. Evaporation of agent spilled due to mechanical breach of one to five containers per warehouse.

2. Burning of agent spilled from breached containers.

3. Burning of the entire inventory in the warehouse, starting at 30 min.

The evaporative release rate is not limited by the floor area, which is tens of thousands of square feet per warehouse. Thus, the evaporative release rate, m_{ev}, is given by Eq. 10-2. For 10-ton containers with agent HD, M = 17,000 lb and a $\approx$ 451 and b $\approx$0.1. Thus, m_{ev} = 0.85 lb/h for 10 containers. This rate of HD release is negligible. Therefore, evaporative release of spilled HD from breached munitions is negligible. For agent VX, the maximum number of breached ton containers is five. In this limiting case, M = 8000 lb and a $\approx$ 49,000, b $\approx$ 0.12. Thus, m_{ev} = 0.003 lb/h for five breached containers. This rate of release is negligible.

The second and third types of releases involve burning of spilled agent from breached containers or burning of all ton containers due to a lack of fire suppression. For these cases, the release consists of the product of the appropriate inventory and the fire release fraction, F. Here, F = 0.025 for agent VX and F = 0.05 for agent HD, consistent with data described above. No credit is taken for agent vapor retention by the warehouse building, even if it is not structurally damaged by the earthquake, because it is not designed with a containment function.

As described in Section 5, an event tree was analyzed for the storage of ton containers at the UMDA and NAAP site warehouses. For the UMDA site, there were 17 release sequences with frequencies above 10^{-10}/yr. Table 10-5 lists these sequences along with the information

TABLE 10-5
AGENT HD RELEASES FROM TON CONTAINERS STORED IN
UMDA WAREHOUSES DURING EARTHQUAKES[a]

Sequence ID	No. of Munitions Damaged	Spilled Munition Agent Burns	No. Warehouses In Which Entire Inventory Burns	Release To Atmopshere (lb)
SLKHF281	0	--	1	2.7×10^5
SLKHF282	0	--	2	5.4×10^5
SLKHC283	1-5	No	0	ϵ[b]
SLKHF284	1-5	Yes	1	2.7×10^5
SLKHF285	1-5	No	1	2.7×10^5
SLKHF286	1-5	Yes	2	5.4×10^5
SLKHC287	2-10	No	0	ϵ
SLKHF288	2-10	Yes	1	2.7×10^5
SLKHF289	2-10	Yes	2	5.4×10^5
SLKHC2810	1-5	No	0	ϵ
SLKHF2811	1-5	Yes	1	2.7×10^5
SLKHF2812	1-5	Yes	2	5.4×10^5
SLKHC2813	2-10	No	0	ϵ
SLKHF2814	2-10	Yes	1	2.7×10^5
SLKHF2815	2-10	Yes	2	5.4×10^5
SLKHC2816	2-10	No	0	ϵ
SLKHF2817	2-10	Yes	2	5.4×10^5

(a) Agent inventory = 5.4×10^6 lb per warehouse, assuming warehouse is full.

(b) ϵ = negligible (below 14 lb).

pertinent to the release calculations. For sequences in which the burning or agent spilled from breached munitions is the only release mode, a range of release is given corresponding to the range of containers breached (1 to 5 or 2 to 10). For sequences in which the non-suppressed fire ignites the entire warehouse inventory, the number of breached containers is unimportant.

Table 10-6 presents the corresponding release results for ton containers stored at the NAAP site. Only five sequences are important since there is only one warehouse at the site. The maximum masses of agent VX released from this site are seven times lower than maximum mass releases of agent HD from UMDA.

In the event tree for spray tanks stored at the TEAD site, there were six significant sequences as given in Table 10-7. Since no spray tanks are mechanically breached, the only consequence variable is whether the unsuppressed fire is not suppressed in one or both warehouses. The releases upon burning of the entire inventory at one or both warehouses are given in Table 10-7. They are 8 to 16 times lower than the maximum release of the same agent (VX) from the NAAP site.

10.2.3. Plant Operation Releases

10.2.3.1. Internal Events. The analysis of agent release due to in-plant accidents used the same calculation models discussed above when applicable. However, many plant operations involve accidents which occur after the munition has been punched and drained. The agent releases for these events are not dependent on the munition failure

TABLE 10-6
AGENT VX RELEASES FROM NAAP WAREHOUSE TON CONTAINERS DURING EARTHQUAKES[a]

Sequence ID	No. of Munitions Damaged	Spilled Munition Agent Burns	Entire Warehouse Inventory Burns	Release To Atmosphere (lb)
SLKVF261	0	--	Yes	7.5×10^4
SLKVC262	1-5	No	No	ϵ[b]
SLKVF263	1-5	Yes	Yes	7.5×10^4
SLKVC264	1-5	No	No	ϵ
SLKVF265	1-5	Yes	Yes	7.5×10^4

(a) Warehouse inventory = 3×10^6 lb of VX, assuming warehouse is full.

(b) ϵ = negligible (below 0.3 lb).

TABLE 10-7
AGENT VX RELEASE FROM SPRAY TANKS STORED AT TEAD WAREHOUSES DURING EARTHQUAKES[a]

Sequence ID	No. Warehouses In Which Entire Inventory Burns	Release To Atmosphere (lb)
SLSVF271	1	4.5×10^3
SLSVF272	2	9.0×10^3
SLSVF273	1	4.5×10^3
SLSVF274	2	9.0×10^3
SLSVF275	1	4.5×10^3
SLSVF276	2	9.0×10^3

[a] Agent inventory = 1.79×10^5 lb of VX, assuming warehouse is full.

models discussed above. The bases for agent releases for these events are as follows:

1. The evaporation rate for an indoor spill was calculated using the D2PC computer code (Ref. 10-1). Allowable surface area for evaporation was also calculated by D2PC for the first 10 min of the accident.

2. The munition inventory in the MHI is 16 packages.

3. The munition inventory in the UPA is six packages.

4. The maximum agent inventory in the TOX and piping is 500 gal in the collection tank, 28 gal in the piping. This inventory is assumed to be present at the time of the accident.

10.2.3.2. Earthquake At MDB.

Burstered Munitions Release

There are two locations in the MDB where agent is present: the unpack area (UPA) and the TOX cubicle. The event trees for burstered munitions consider the potential scenarios leading to damage and agent release for one or more munitions in the UPA, damage and agent release of the TOX, or both. For the various seismic intensities, there were four sequences with significant frequencies of obtaining damage and release, all involving fire in the MDB. For convenience these are summarized as follows:

Sequence	Earthquake Fails MDB	Munition Puncture	TOX	Fire Suppressed
P033	No	Not relevant	Intact	No
P025	Yes	Yes	Intact	Yes
P026	Yes	Yes	Intact	No
P029	Yes	No	Intact	No

Damage or failure of the MDB by the MDB by the earthquake is important since it allows release to atmosphere of any agent spill starting from time zero. Later, the MDB can fail due to nonsuppression of the fire. Other important intermediate events involve mechanical puncture and spill of a single munition during processing. Other munition failure modes such as early detonation of a single processed munition or puncture of a packed munition are screened out on the basis of low probability. Failure of the TOX, resulting in spill of the TOX agent inventory, due to the earthquake also is screened out on the basis of low probability. Both the mechanical failure mode for the TOX and the thermal failure of the TOX and piping is low probability. If the fire is not suppressed, it has the potential for failing the munitions in the UPA (entire inventory considered).

The above four sequences involve one or more combinations of two types of releases:

Sequences P026, P029, and P033	-	Fire/detonation involving entire UPA inventory.
Sequence P025	-	Evaporation release of one munition inventory, or a burn release of one munition inventory.

The algorithms for calculating each of these types of release are described below.

For the first type, the agent inventory in the UPA is six packages containing one munitions pallet per package. Thus, the total inventory is the inventory of a single munition, B (in pounds of agent), times the number of munitions per pallet, C, times six. Thus,

$$\text{UPA inventory} = 6 \times B \times C \quad . \tag{10-3}$$

Table 10-3 presents values of the single munitions inventory B and the total UPA inventory for the various burstered munitions.

The fire/detonation release is calculated by the equation,

$$\text{Fire/detonation release} = (\text{UPA) inventory}) \, (0.25 + (0.75 \, F) \quad , \qquad (10\text{-}4)$$

where F is the release fraction due to incomplete burning. Here,

$$F = \begin{cases} 0.10 \text{ for agent GB} \\ 0.05 \text{ for agent H} \\ 0.025 \text{ for agent VX} \end{cases} \quad . \qquad (10\text{-}5)$$

These values represent the estimated unburned vapor release during a fire. Consistent with other initiating events, 0.25 is taken to be the release due to detonation of some of the bursters and spraying of agent. The fire release fraction is applied to the remaining 75% of the inventory.

The other type of release consists of indoor evaporation or burning of spilled agent from one munition released directly to the atmosphere (failed MDB). The burn release is simply the munition inventory times the fire release fraction, F. The computer code D2PC is used to calculate the evaporative release. Values for the evaporative releases are presented in Table 10-8 for the various burstered munitions. Only agent GB evaporative released is significant since the releases for other agents are below threshold values for significant offsite consequences. These threshold values are 0.4 lb for agent GB, 0.3 lb for VX, and 14 lb for HD.

The evaporative releases are based on application of the evaporation data for a 6-h time period. This is the time estimated for mitigation or cleanup of the spill. For single burstered munition inventories, the 1/32-in. spill area is less than the UPA floor area. Since the

TABLE 10-8
AGENT INVENTORIES AND RELEASES

Munition Type	Agent Type	UPA Inventory (lb)	Agent Release (lb)					
			P026, P029, P033			P025		
			UPA Fire	Deton	Total	Evaporation	Burn	Net
Burstered Munitions								
Mortar	H	864	32	216	248	ϵ	0.30	0.30
Cartridge	GB	230	17	58	75	0.20	0.16	0.20
	H	461	17	115	132	ϵ	0.16	0.16
Mine	VX	2,268	43	567	610	ϵ	0.26	0.26
Projectile (155 mm)	GB	312	23	78	101	0.23	0.65	0.65
	H	562	21	141	162	ϵ	0.59	0.59
	VX	288	5	72	77	ϵ	0.15	0.15
Projectile (8 in.)	GB	522	39	131	170	0.27	0.15	0.27
	VX	522	10	131	141	ϵ	0.36	0.36
Rocket	GB	963	72	241	313	0.25	1.10	1.0
	VX	900	17	225	242	ϵ	0.25	0.25
Nonburstered Munitions								
Bomb	GB	2,640	264	NA	264	0.90	22	22
Ton container	GB	9,000	900	NA	900	5.60	150	150
	H	10,200	510	NA	510	ϵ	85	85
	VX	9,600	240	NA	240	ϵ	40	40
Spray tank	VX	8,136	203	NA	203	ϵ	34	34

Note: ϵ = negligible, NA = not applicable, P033 applies to burstered munitions only.

floor area slopes to two 2 x 2 x 2 ft sumps, the following procedure is used.

Initially, the spill is assumed to wet the sloped floor area. Thus, the above equation is applied, without modifications due to any area restriction, for a selected 10-min time period. After that, the liquid is assumed to run down the shallow slope to one of the sumps, which is large enough to contain the entire burstered munition volume. Between 10 min and an estimated accident mitigation time of 6 h, the evaporation occurs at a rate dictated by the sump area of 4 ft^2. This rate is essentially that given by Eq. 10-2 with M corresponding to the mass of liquid in a 1/32-in. layer of the sump pool, rather than the entire munition inventory. The evaporative releases between 0 and 10 min and 10 min and 6 h are summed to get the total evaporation release.

Since it is not known from the event tree analysis whether the fire engulfs the sump, the approach in this analysis is to take the maximum of the fire release and the evaporative release. Table 10-8 shows these releases. Generally, the fire release dominates.

Table 10-8 presents the calculated releases for the significant accident sequences.

In sequence P033, the building remains intact from the earthquake, so no release occurs for the initial 10 min, regardless of whether a single munition spill occurs or not. The ensuing fire is not suppressed and the UPA inventory is ignited at 10 min, resulting in a fire/detonation release.

In sequence P025, the MDB is damaged, so that the agent spill from the single munition puncture is released to atmosphere. The fire is suppressed before additional munitions are involved. Thus, the release

consists of evaporation if the fire area is not coincident with the spill area or a burn release if the fire burns the spilled agent.

In sequences P026 and P029, the release during the initial 10 min is small (the same as the sequence P025). But since the fire is not suppressed, the UPA inventory is ignited and the total release becomes the (same as sequence P033).

Table 10-8 shows that significantly large releases (75 to 610 lb) occur for sequences P033, P026, and P029. Releases for sequence P025 are small.

Nonburstered Munitions Release

The event tree for nonburstered munitions contains three sequences with frequencies above the screening threshold of 10^{-10} per year. All of these involve earthquake-induced damage to the MDB and fire. They are as follows:

Sequence	Munition Puncture	TOX	Fire Suppressed
P025	Yes	Intact	Yes
P026	Yes	Intact	No
P029	No	Intact	No

These sequences involve the same types of releases as for the burstered munitions with one exception. Nonsuppressed fire (lasting more than 10 min) for burstered munitions in the UPA involves both detonation and fire, while only fire is involved for nonburstered munitions. Also, the ignition time is 30 min for nonburstered munitions. Thus, the release algorithm is changed to:

$$\text{UPA release} = (\text{UPA inventory}) \times F \quad . \qquad (10\text{-}6)$$

The evaporation algorithm is similar for burstered and nonburstered munitions. Inventory algorithms are the same.

Table 10-8 presents the inventories of agents in nonburstered munitions or in the TOX. The larger inventory (over 10^3 lb) of the nonburstered munitions causes some special considerations for a puncture release. A puncture is interpreted to consist of a 1.5-in. diameter hole. The agent flow rate out the hole is approximately 100 lb/min, which means that the entire munition inventory spills out in about 1/4 h. In the UPA, the spill is limited to 2140 ft^2 of floor area during the initial 10 min before the liquid flows to the sump. when 379 lb of agent spills into this area, a critical pool thickness is reached, namely 1/32 in., and the evaporation rate levels off. After 10 min, the sump will be overflowed for certain munitions. The pool area is calculated based on a slope of 1/4 in. for each foot of floor space and the evaporation rate is adjusted for that area.

Results of the inventory and release calculations for nonburstered munitions are summarized in Table 10-8. The effect of fire in the UPA is found to be most important.

10.2.4. Transport Releases

For onsite truck transport, each truck will carry up to four ONCs. The agent inventory of each ONC is summarized in Table 10-3 for the various munitions.

Table 10-9 presents the truck accident release calculations. Those sequences where no release values are given were screened out on the basis of low frequency. Note that detonation releases occur only where burstered munitions are involved. The only significant release sequence is V007, involving aircraft crash, mechanical rupture, and evaporation.

TABLE 10-9
RESULTS OF ONSITE TRANSPORT RELEASE ANALYSIS

Scenario	Agent Available[a]	Spilled (lb)	Destroyed (lb)	Vapor (lb)	Detonated (lb)	Duration Time
VOKHS001	3400	--	--	--	--	--
VOPGS001	760	--	--	--	--	--
VOPHS001	1404	--	--	--	--	--
VOPVS001	756	--	--	--	--	--
VOQGS001	870	--	--	--	--	--
VORGS001	645	--	--	--	--	--
VORVS001	612	--	--	--	--	--
VOKHS002	3400	--	--	--	--	--
VOPGS002	760	--	--	--	--	--
VOPHS002	1404	--	--	--	--	--
VOPVS002	756	--	--	--	--	--
VOQGS002	870	--	--	--	--	--
VORGS002	645	--	--	--	--	--
VORVS002	612	--	--	--	--	--
VOKHS003	3400	1700.0	--	--	--	2 h
VOPGS003	760	6.5	--	--	--	2 h
VOPHS003	1404	11.7	--	--	--	2 h
VOPVS003	756	6.3	--	--	--	2 h
VOQGS003	870	14.5	--	--	--	2 h
VORGS003	645	10.75	--	--	--	2 h
VORVS003	612	10.2	--	--	--	2 h
VOPGC004	760	--	--	--	--	--
VOPHC004	1404	--	--	--	--	--
VOPVC004	756	--	--	--	--	--
VOQGC004	870	--	--	--	--	--
VORGC004	645	--	435.37	48.3	161.25	20 min
VORVC004	612	--	447.5	11.5	153.0	20 min
VOKHF005	3400	--	--	--	--	--
VOKHS006	3400	3400.0	--	--	--	Instant
VOPGC006	760	532.0	--	--	114.0	Instant
VOPHC006	1404	982.8	--	--	210.6	Instant
VOPVC006	756	529.2	--	--	113.4	Instant
VOQGC006	870	609.0	--	--	130.5	Instant
VORGC006	645	451.5	--	--	96.75	Instant
VORVC006	612	428.4	--	--	91.8	Instant

TABLE 10-9 (Continued)

Scenario	Agent Available[a]	Spilled (lb)	Destroyed (lb)	Vapor (lb)	Detonated (lb)	Duration Time
VOKHF007	3400	--	3230.0	170.0	--	20 min
VOPGC007	760	--	513.0	57.0	190.0	20 min
VOPHC007	1404	--	1000.3	52.7	351.0	20 min
VOPVC007	756	--	552.8	14.2	189.0	20 min
VOQGC007	870	--	587.2	65.3	217.5	20 min
VORGC007	645	--	435.37	48.3	161.25	20 min
VORVC007	612	--	447.5	11.5	153.0	20 min
VOKHS009	3400	--	--	--	--	--
VOPGS009	760	--	--	--	--	--
VOPHS009	1404	--	--	--	--	--
VOPVS009	756	--	--	--	--	--
VOQGS009	870	--	--	--	--	--
VORGS009	645	--	--	--	--	--
VORVS009	612	--	--	--	--	--
VOKHS010	3400	--	--	--	--	--
VOPGS010	760	--	--	--	--	--
VOPHS010	1404	--	--	--	--	--
VOPVS010	756	--	--	--	--	--
VOQGS010	870	--	--	--	--	--
VORGS010	645	--	--	--	--	--
VORVS010	612	--	--	--	--	--
VOKHS011	3400	1700.0	--	--	--	2 h
VOPGS011	760	6.5	--	--	--	2 h
VOPHS011	1404	11.7	--	--	--	2 h
VOPVS011	756	6.3	--	--	--	2 h
VOQGS011	870	14.5	--	--	--	2 h
VORGS011	645	10.75	--	--	--	2 h
VORVS011	612	10.2	--	--	--	2 h
VOPGC012	760	--	513.0	57.0	190.0	20 min
VOPHC012	1404	--	1000.3	52.7	351.0	20 min
VOPVC012	756	--	552.8	14.2	189.0	20 min
VOQGC012	870	-	587.2	65.3	217.5	20 min
VORGC012	645	--	435.4	48.4	161.3	20 min
VORVC012	612	--	447.5	11.5	153.0	20 min
VOKHF013	3400	--	3315.0	85.0	--	1 h

TABLE 10-9 (Continued)

Scenario	Agent Available[a]	Spilled (lb)	Destroyed (lb)	Vapor (lb)	Detonated (lb)	Duration Time
VOKHS014	3400	1700.0	--	--	--	2 h
VOPGS014	760	6.5	--	--	--	2 h
VOPHS014	1404	11.5	--	--	--	2 h
VOPVS014	756	6.3	--	--	--	2 h
VOQGS014	870	14.5	--	--	--	2 h
VORGS014	645	10.75	--	--	--	2 h
VORVS014	612	10.2	--	--	--	2 h
VOPGS015	760	32.5	--	--	6.5	Instant
VOPHS015	1404	58.5	--	--	11.7	Instant
VOPVC015	756	31.5	--	--	6.3	Instant
VOQGC015	870	72.5	--	--	14.5	Instant
VORGC015	645	623.5	--	--	21.5	Instant
VORVC015	612	591.6	--	--	20.4	Instant

(a)From Table 1-2, "Transportation of Chemical Agents and Munitions: A Concept Plan," U.S. Army, June 30, 1987.

10.2.5. Uncertainties

No uncertainty analysis was performed for the agent release analysis. The releases reported are treated as conservative estimates, rather than central estimates, since they are based on assumptions which are often conservative. Examples are: (1) use of early thresholds of munition failure relative to the data (Appendix F), (2) worst-case number of adjacent munition ruptures for a munition detonation in a pallet, (3) use of maximum rather than average inventories, and (4) upper bound fire release factors, relative to the data.

10.3. REFERENCES

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11. RESULTS

The analysis of the potential for agent release to the atmosphere from accident scenarios related to the onsite disposal option included the following major activities: (1) storage, (2) handling activities associated with the transport of munitions, (3) onsite transportation, and (4) plant operations associated with the demilitarization of munitions. This section discusses some of the accident probability and agent release results associated with these activities.

The results of the analysis of the various activities encompassing the onsite disposal option cannot be presented in the same units, i.e., annual frequencies, because of the possible divulgence of classified information. This is only possible for some storage and plant operation accident scenarios. For accident scenarios related to the handling activities at the different sites, the unclassified portion of the probabilistic analysis is given in terms of frequency of accidents per pallet of munitions (or as a container of munitions). For onsite transportation accidents, the basic results are reported in terms of accident frequency per vehicle mile. These probabilities/unit are then multiplied by the number of handling operations or vehicle miles traveled during the stockpile disposal program.

The evaluation of the actual risk to the public and environment requires agent dispersion calculations which are not in the scope of the study reported here. Despite this limitation, the results discussed herein still provide useful insights on the contributions of the various disposal activities to the risk of an agent release. These insights are discussed below.

11.1. ACCIDENT SCENARIOS DURING STORAGE

11.1.1. Internal Events

There were no significant internal event initiators of accidents during storage at the disposal site before movement to the demilitarization facility. Per unit operation, forklift drop accidents occur more frequently than forklift tine punctures. Also, the use of a lifting beam instead of a tine leads to an order of magnitude decrease in drop frequency.

11.1.2. External Events

These events involve accidents caused by natural phenomena or human activity affecting munitions in storage igloos, open storage areas, holding areas, or warehouses. If these are assumed to be full of munitions, the agent inventories range up to 100, 1000, and 2000 tons, respectively, for storage igloos, open areas, and warehouses. The most frequent external accidents having significant release involve mild intensity earthquakes or small airplane crashes (order depending on site). Amounts of available agent inventories released in these events are on the order of fractions of one percent or less (munition punctures, drops, etc.).

The largest releases occur for a large aircraft crash, a meteorite strike, or a severe earthquake, especially when a warehouse (at NAAP, TEAD, or UMDA) is involved. These can result in up to 10 percent of the agent inventory released for scenarios involving a fire which has the potential (duration) for destroying the entire inventory of an igloo or warehouse. The munitions stored in warehouses contain only VX or mustard which have much slower evaporation rates than GB and hence are not easily dispersed into the atmosphere. Thus, warehouse scenarios involving only spills are not significant risk contributors. The warehouse at UMDA has the potential for the largest release. Meteorite

strike-initiated sequence median frequencies are one to two orders of magnitude lower than the aircraft crash-induced sequence frequencies. As expected, munitions stored outdoors are generally more susceptible to large aircraft crashes than those stored in warehouses or igloos, but releases are lower. Both APG and PBA have ton containers stored outdoors, and the aircraft crash probabilities at these sites are somewhat higher than at the other sites. Igloos appear to provide only minimal protection from direct crashes of large planes, but releases are an order of magnitude lower. The releases are more severe if burstered munitions are involved.

11.2. ACCIDENT SCENARIOS DURING HANDLING

Included in the handling analysis are (1) single munition or pallet movements by hand, forklift, or other equipment; (2) packing or unpacking pallets into transportation containers; and (3) loading and unloading packages from trucks.

The results indicate that dropped munitions, whether in palletized form or not, occur more frequently than either forklift tine puncture or forklift collision accidents. In fact, the frequency of forklift collision accidents which lead to the munitions falling off the forklift is an order of magnitude lower than the drop accidents. Furthermore, the type of clothing an operator is wearing while handling these munitions influence the drop frequency value. An operator wearing Level A clothing is more likely to commit an error that would cause the munition to be dropped than when he is wearing more comfortable clothing.

The results also indicate that spray tanks (in overpacks) have relatively higher drop frequencies than other munitions. This is largely due to the assumption that spray tanks will be lifted and moved to the truck (for loading or unloading) using forklift with tines. The drop frequency using the tines is an order of magnitude higher than with the use of lifting beams.

For bare munitions, the rockets seem to be the most prone to punctures from drops or forklift tine accidents. However, the onsite transport container (ONC) itself also affects the puncture probability. However, bare munitions have higher puncture probabilities than munitions in ONCs. This observation is of course not quite evident in the final results presented because there are more handling operations involving possible drops of ONCs than bare munitions.

Bulk items that are punctured lead to larger releases than other munitions such as projectiles or rockets. Bombs are of concern because

they contain GB which evaporates more readily than the other agent types. The agent vapor releases range up to 170 lb (thermal failure of all munitions in an ONC), or up to 10 percent of the available agent inventory.

Within the types of handling accidents, the events designated as HO, which are related to the packaging of munitions in ONCs and their movement from storage (sending sites) to the munitions handling igloo (MHI), predominate over handling accidents related to the facility (HF). This is largely because (1) there are more handling operations involved in the HO accidents, (2) HF accidents generally involve munitions in ONCs, which provides them with some protection from puncture, and (3) HF accidents involving bare munitions occur inside the munitions demilitarization building (MDB) which is designed for vapor containment; hence, including the probability of a detonation which destroys the vapor containment barrier, both the frequency of a release and the release itself are relatively lower.

The frequency results for the handling accidents could not be compared with the accidents from other activities, such as plant operations, because of differences in units. To get some perspective on how they compare on a yearly basis, we can estimate the number of pallets that could be handled based on the plant annual processing rates. For illustrative purposes we calculate the number of bomb pallets that are required to meet the annual plant processing rate as:

$$5.4 \text{ bombs/h} \times 24 \text{ h/day} \times 5 \text{ day/week} \times 52 \text{ week/yr} / 2 \text{ bombs/pallet} = 16{,}848 \text{ pallets/yr} \quad .$$

By multiplying the HC1 sequence frequency for TEAD (1.2×10^{-7}/pallet) with the number of pallets/yr, the annual frequency is 2.0×10^{-3}/yr. Thus, handling accidents which lead to significant agent releases (in particular, agent GB) are dominant risk contributors because of the relatively higher annual frequency values. Of course

depending on the actual munition inventory, the value of annual frequency may either increase or decrease when converted to the more meaningful per stockpile basis.

11.3. ACCIDENT SCENARIOS DURING PLANT OPERATIONS

Included in the analysis for this phase are all malfunctions during agent processing/incineration within the MDB or external events affecting drained and undrained agent in the MDB, including those in the unpack area (UPA) (up to 10^4 lb of agent available) and munitions awaiting processing in the MHI, up to 3×10^4 lb of agent available. After unpacking, the munitions are processed by conveyor to the burster removal area, mine punch-and-drain area, projectile mortars disassembly area, rocket and burster shearing machines, mine machine for burster removal, a bulk item drain station, a toxic cubicle (TOX) agent storage tank, furnaces for explosive deactivation, metal parts decontamination, and agent and dunnage incinerators, as appropriate.

11.3.1. Internal Events

Because of the engineered safety features provided in the plant design, both the frequency of release and magnitude of release associated with accidents initiated by equipment failure and human error are relatively small. Among the large number of accident scenarios analyzed, the highest frequency scenario (P052) is initiated by an inadvertent feed of an unpunched burstered munition to the dunnage incinerator (10^{-2}/yr for mines; 5×10^{-3}/yr for other munitions). As a result of detonation, one burstered munition inventory is released to the atmosphere as vapor (only up to 15 lb of agent).

The largest amount of agent vapor release occurs for a metal parts furnace explosion (P044) with ventilation failure (one bulk item inventory release, up to 1700 lb). However, this scenario was assessed to have a very low frequency, around 10^{-10}/yr. Another event with up to several hundred pounds of vapor release is P048, munition detonation in the explosive containment room vestibule with subsequent fire spreading to unpacked munitions. However, this scenario also has a low frequency, around 10^{-9}/yr.

11.3.2. External Events

Aircraft crashes dominate the external event frequency, and there is little difference between direct and indirect crashes. The small difference is attributed to offsetting effects. Although the indirect crash has smaller conditional probabilities of failures than the direct crash, the risk model utilizes a larger target area for the indirect crash. There is very little distinction in the frequency of aircraft crashes with or without fire, since historical data indicate that there is roughly a 50 percent chance that the crash of an aircraft will involve a fire. The frequency of a crash onto the MDB is considerably larger than that for the MHI because the surface area of the MDB is more than 30 times larger than the MHI.

The frequency of large aircraft crashes is estimated to be higher at ANAD than it is for TEAD. This impacts the regional versus national collocation option. The accident scenario involving the crash of an airplane onto the outdoor agent piping system for the modified CAMDS facility at TEAD has a frequency of about 10^{-8}/yr with up to 55 lb of vapor release. This scenario includes both large and small aircraft crashes. The frequency of small aircraft (including helicopters) crashes is at least two orders of magnitude higher than the frequency of large aircraft crashes at TEAD.

The frequencies of earthquake-induced accident scenarios are generally higher for TEAD than for ANAD since TEAD is located in a region more prone to earthquakes. Sequence PO33, which represents an earthquake-initiated munition fall and fire but with the MDB and TOX intact, has the highest frequency (2×10^{-6}/yr for ANAD and 5×10^{-5}/yr for TEAD). This sequence involves the detonation of all munitions (if burstered) in the UPA since the fire is not suppressed in this sequence.

All accident sequences related to tornadoes or meteorites were estimated to occur at frequencies of less than 10^{-10}/yr and thus were screened out.

11.4. ACCIDENT SCENARIOS DURING TRANSPORT

11.4.1. Onsite Transportation

When munitions at their storage locations are ready for demilitarization, they are transferred into onsite containers and then moved by truck to the MHI. The onsite transport accidents are identified as VO scenarios. The agent available in a truck carrying (four) ONCs ranges up to 7000 lb.

As a result of analysis for both internally initiated events (human error or equipment failure) and externally initiated events, the following conclusions were reached:

1. The ONC package provides a substantial protection from impact and crush forces. The results show that accident frequencies resulting in impact or crush failure are insignificant. This is largely due to the administrative control to be imposed during truck travel which limits truck speed to no more than 20 mph. The impact forces at this velocity are not sufficient to breach the containment.

2. The probability of puncture resulting from truck collision/overturn is the most important mechanical failure mode.

3. Truck accidents which generate fires are not likely to detonate burstered munitions inside onsite packages, since they provide 15-min protection from an all-engulfing fire. These scenario frequency results are quite low because of the administrative control for limiting the amount of fuel in the truck so as not to exceed a 10-min fire.

4. For tornado-initiated accidents, puncture as a result of truck overturn is the dominant contributor to the sequence frequency.

5. Generation of undue forces during truck accidents that could cause burster detonations has a small contribution to the overall truck transportation risk.

6. The amount of agent spilled or burned during truck accidents resulting in the breach in containment by puncture forces generally involve the agent content of one munition. Up to 10 percent is released as vapor.

7. ONCs can fail when an aircraft crashes into the truck (V06, V07). The entire truckload is involved, and up to 10 percent is released as a vapor. Hence, aircraft crash-initiated truck accidents have the most severe consequences. It should be *noted, however, that none of the accident sequences* has a frequency greater than 10^{-7}/yr.

11.5. UNCERTAINTIES IN THE ANALYSIS

In assessing the risks associated with the onsite disposal alternative, every effort was made to perform best-estimate analyses, i.e., "realistic" evaluation and quantification of the accident sequence frequencies and associated agent releases. The use of pessimistic or conservative modeling techniques or data for quantification violates the intent of the probabilistic nature of the study. Realistic modeling and quantification permits a balanced evaluation of risk contributors and comparison of alternatives. However, for realistic or best-estimate calculations, the obvious concern is the accuracy of the results. Uncertainty analysis addresses this concern.

11.5.1. Sources of Uncertainty

Since the event sequences discussed in Section S.3 have not actually occurred, it is difficult to establish the frequency of the sequence and associated consequences with great precision. For this reason, many parameters in a risk assessment are treated as probabilistically distributed parameters, so that the computation of sequence frequencies and resulting consequences can involve the probabilistic combination of distributions.

There are three general types of uncertainty associated with the evaluations reported in this document: (1) modeling, (2) data, and (3) completeness.

There exist basic uncertainties regarding the ability of the various models to represent the actual conditions associated with the sequence of events for the accident scenarios that can occur in the storage and disposal activities. The ability to represent actual phenomena with analytical models is always a potential concern. The use of fundamental models such as fault trees and event trees is sometimes simplistic because most events depicted in these models are treated as

leading to one of two binary states: success or failure (i.e., partial successes or failures are ignored). Model uncertainties are difficult to quantify and are addressed in this study by legitimate efforts of the analysts to make the models as realistic as possible. Where such realism could not be achieved, conservative approaches were taken.

No uncertainty from oversights, errors, or omission from the models used (e.g., event trees and fault trees) is included in the uncertainty analysis results. Including these uncertainties is beyond the state-of-the-art of present day uncertainty analysis.

The uncertainties in the assignment of event probabilities (e.g., component failure rates and initiating event frequencies) are of two types: intrinsic variability and lack of knowledge. An example of intrinsic variability is that where the available experience data is for a population of similar components in similar environments, but not all the components exhibit the same reliability. Intrinsic variations can be caused, for example, by different manufacturers, maintenance practices, or operating conditions. A second example of intrinsic variability is that related to the effects of long-term storage on the condition of the munitions as compared to their original configuration. Lack of knowledge uncertainty is associated with cases where the model parameter is not a random or fluctuating variable, but the analyst simply does not know what the value of the parameter should be. Both of these data uncertainty types are encountered in this study.

11.5.2. Uncertainties

The sequence frequency results discussed in this report are presented in terms of a median value and a range factor of a probability distribution representing the frequency of interest. The range factor represents the ratio of the 95th percentile value of frequency to the 50th percentile (i.e., median) value of frequency. The uncertainty in the sequence frequency is determined using the STADIC-2 program

(Ref. 11-1) to propagate the uncertainties associated with each of the events in the fault trees or event trees through to the end result. Some scenarios, such as those associated with tornado missiles and low-impact detonations have rather large uncertainties. The difficulty with tornado-generated missiles lies with the difficulty in accurately modeling the probability that the missile will be in the proper orientation to penetrate the munition and in predicting the number of missiles per square foot of wind. The difficulty with the low-impact detonations lies with the sparse amount of data available and its applicability to the scenarios of interest. In general, uncertainties tend to be large when the amount of applicable data is small and vice versa.

11.6. REFERENCE

11-1. Koch, P., and H. E. St. John, "STADIC-2, A Computer Program for Combining Probability Distribution," GA Technologies Inc., GA-A16277, July 1983.

APPENDIX A
REFERENCE LIST OF ACCIDENT SEQUENCES

A.1. REFERENCE LIST OF ACCIDENT SEQUENCES

A reference list of accident sequences is presented here. The list is arranged by the particular demilitarization phase with which a given sequence is associated. Accident sequences related to storage are presented first followed by plant operations, handling, and onsite transportation. The sequences can be identified by the coding scheme presented in Section 4 of this document. Following the sequences ID, a brief description of the accident is given along with an indication as to whether or not the sequence was considered for further analysis. The bases for scenario screening are provided in the logic model section, Section 4, of the main body of this report.

ACCIDENT SEQUENCES FOR STORAGE

Sequence ID	Sequence Description	Considered for Further Analysis
SL1	Munition develops a leak during the in-between inspection period.	Yes
SL2	Munition punctured by forklift tine during leaker-handling activities.	Yes
SL3	Spontaneous ignition of rocket during storage (not analyzed for lack of quantitative data).	No
SL4	Large aircraft direct crash onto storage area; fire not contained in 30 min. (Note: Assume detonation occurs if burstered munitions hit; fire involving burstered munitions not contained at all.)	Yes
SL5	Large aircraft indirect crash onto storage area; fire not contained in 30 min. (See note in SL4.)	Yes
SL6	Tornado-generated missiles strike the storage magazine, warehouse, or open storage area; munitions breached (no detonation).	Yes
SL7	Severe earthquake breaches the munitions in storage igloos; no detonations.	Yes
SL8	Meteorite strikes the storage area; fire occurs; munitions breached (if burstered, detonation also occurs).	Yes
SL9	Munition dropped during leaker isolation operation; munition punctured.	Yes
SL10	Storage igloo or warehouse fire from internal sources.	No
SL11	Munitions are dropped due to pallet degradation.	No
SL12	Liquid petroleum gas (LPG) infiltrates igloo/building.	No
SL13	Flammable liquids stored in nearby facilities explode; fire propagates to munition warehouse (applies to NAAP).	No

ACCIDENT SEQUENCES FOR STORAGE (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
SL14	Tornado-induced building collapse leads to breaching/detonation of munitions.	No
SL15	Small aircraft direct crash onto warehouse or open storage yard; fire occurs; not contained in 30 min.	Yes
SL16	Large aircraft direct crash; no fire; detonation (if burstered).	Yes
SL17	Large aircraft direct crash; fire contained within 30 min (applies to nonburstered munitions only).	Yes
SL18	Small aircraft direct crash onto warehouse or open storage yard; no fire.	Yes
SL19	Small aircraft direct crash onto warehouse or open storage yard; fire contained in 30 min.	Yes
SL20	Large aircraft indirect crash onto storage area; no fire.	Yes
SL21	Large aircraft indirect crash onto storage area; fire contained in 30 min.	Yes
SL22	Severe earthquake leads to munition detonation.	Yes
SL23	Tornado-generated missiles strike the storage igloo and leads to munition detonation.	Yes
SL24	Lightning strikes ton containers stored outdoors.	Yes
SL25	Munition dropped during leaker isolation; munition detonates.	Yes
SL261	Earthquake occurs; NAAP warehouse is intact; no ton containers damaged; fire occurs.	Yes
SL262	Earthquake occurs; NAAP warehouse is intact; ton container damaged; no fire.	Yes
S1263	Earthquake occurs; NAAP warehouse is intact; ton container damaged; fire occurs.	Yes

ACCIDENT SEQUENCES FOR STORAGE (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
SL264	Earthquake occurs; NAAP warehouse is damaged; ton containers damaged; no fire.	Yes
SL265	Earthquake occurs; NAAP warehouse is damaged; ton containers damaged; fire occurs.	Yes
S1271	Earthquake occurs; TEAD warehouses intact; munitions intact; fire occurs at one warehouse.	Yes
SL272	Earthquake occurs; TEAD warehouses intact; munitions intact; fire occurs at two warehouses.	Yes
SL273	Earthquake occurs; one TEAD warehouse is damaged; munitions intact; fire occurs at one warehouse.	Yes
SL274	Earthquake occurs; one TEAD warehouse is damaged; munitions intact; fire occurs at two warehouses.	Yes
SL275	Earthquake occurs; two TEAD warehouses damaged; munitions intact; fire occurs at one warehouse.	Yes
SL276	Earthquake occurs; two TEAD warehouses damaged; munitions intact; fire occurs at two warehouses.	Yes
SL281	Earthquake occurs; UMDA warehouses intact; munitions intact; fire occurs at one warehouse.	Yes
SL282	Earthquake occurs; UMDA warehouses intact; munitions intact; fire occurs at two warehouses.	Yes
SL283	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; no fire occurs.	Yes
SL284	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at warehouse with damaged munitions.	Yes
SL285	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at warehouse with undamaged munitions.	Yes
SL286	Earthquake occurs; UMDA warehouses intact; munitions in one warehouse damaged; fire occurs at two warehouses.	Yes

ACCIDENT SEQUENCES FOR STORAGE (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
SL287	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; no fire occurs.	Yes
SL288	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; fire occurs at warehouse with damaged munitions.	Yes
SL289	Earthquake occurs; UMDA warehouses intact; munitions in two warehouses damaged; fire occurs at two warehouses.	Yes
SL2810	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; no fire occurs.	Yes
SL2811	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; fire occurs at warehouse with damaged munitions.	Yes
SL2812	Earthquake occurs; one UMDA warehouse damaged; munitions in one warehouse damaged; fire occurs at two warehouses.	Yes
SL2813	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; no fire occurs.	Yes
SL2814	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; fire occurs warehouse with damaged munitions.	Yes
SL2815	Earthquake occurs; one UMDA warehouse damaged; munitions in two warehouses damaged; fire occurs at two warehouses.	Yes
SL2816	Earthquake occurs; two UMDA warehouses damaged; munitions in two warehouses damaged; no fire occurs.	Yes
SL2817	Earthquake occurs; two UMDA warehouses damaged; munitions in two warehouses damaged; fire occurs at both warehouses.	Yes

ACCIDENT SEQUENCES FOR PLANT OPERATIONS - EXTERNAL EVENTS

Sequence ID	Sequence Description	Considered for Further Analysis
P01	Tornado-generated missile puncture/crush munitions in the MHI.	Yes
P02	Tornado-generated missile detonate munitions in the MHI.	Yes
P03	Tornado-generated missile puncture/crush munitions in the UPA.	Yes
P04	Tornado-generated missile detonate munitions in the UPA.	Yes
P05	Tornado-generated missile damages the agent piping system between the BDS and TOX at TEAD (bulk-only facility).	Yes
P06	Meteorite strikes the MHI.	Yes
P07	Meteorite strikes the UPA.	Yes
P07A	Meteorite strikes the TOX.	Yes
P08	Meteorite strikes the agent piping system between the BDS and TOX at TEAD (bulk-only facility).	Yes
P09	Direct large aircraft crash onto the MHI; no fire.	Yes
P010	Direct large aircraft crash onto the MHI; fire not contained in 0.5 h.	Yes
P011	Direct large aircraft crash onto the MHI; fire contained in 0.5 h.	Yes
P012	Direct large aircraft crash damages the MDB; no fire.	Yes
P013	Direct large aircraft crash damages the MDB; fire not contained in 0.5 h.	Yes
P014	Direct large aircraft crash damages the MDB; fire contained in 0.5 h.	Yes
P015	Indirect large aircraft crash damages the MHI; no fire.	Yes

ACCIDENT SEQUENCES FOR PLANT OPERATIONS - EXTERNAL EVENTS (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
P016	Indirect large aircraft crash damages the MHI; fire not contained in 0.5 h.	Yes
P017	Indirect large aircraft crash damages the MHI; fire contained in 0.5 h.	Yes
P018	Indirect large aircraft crash damages the MDB; no fire.	Yes
P019	Indirect large aircraft crash damages the MDB; fire not contained in 0.5 h.	Yes
P020	Indirect large aircraft crash damages the MDB; fire contained in 0.5 h.	Yes
P021	Direct crash of a large or small aircraft damages the outdoor agent piping system at TEAD; no fire.	Yes
P022	Direct crash of a large or small aircraft damages the outdoor agent piping system at TEAD; fire occurs and not contained.	Yes
P023	Earthquake causes the munitions in the MHI to fall and be punctured.[a]	No
P024	Earthquake causes munitions in the MHI to fall and detonate.[a]	No
P025	Earthquake damages the MDB structure, munitions fall and are punctured; fire suppressed.	Yes
P026	Earthquake damages the MDB structure, munitions fall and are punctured; earthquake also initiates fire; fire suppression system fails.	Yes
P028A[b]	Earthquake damages the MDB structure, munitions fall and are punctured; TOX damaged; fire occurs; fire suppressed.	No
P028	Earthquake damages the MDB structure, munitions fall and are punctured; TOX damaged; fire occurs; fire suppression system fails.	No
P029	Earthquake damages the MDB; munitions are intact; fire occurs; fire suppression system fails.	Yes

ACCIDENT SEQUENCES FOR PLANT OPERATIONS - EXTERNAL EVENTS (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
P030	Earthquake damages the MDB; munitions are intact; TOX damaged; no fire occurs.[c]	No
P031A	Earthquake damages the MDB; munitions are intact; TOX damaged; fire occurs; fire suppressed.	No
P031	Earthquake damages the MDB; munitions are intact; TOX damaged; fire occurs; fire not suppressed.	No
P032	Earthquake causes munitions to fall and detonate; MDB breached by detonation; the TOX is intact; no fire.[c]	No
P033	Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is intact; earthquake also initiates fire; fire suppression system fails.	Yes
P034	Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is damaged; fire occurs; fire suppression system fails.	No

[a]Screened out due to design changes.

[b]Sequence 27 not used.

[c]Screened out on the basis of frequency.

ACCIDENTS FOR PLANT OPERATIONS - INTERNAL EVENTS

Sequence ID	Sequence Description	Considered for Further Analysis
P041	One munition falls off the conveyor in the ECV due to a process upset or improper loading and is punctured. The spill is not cleaned up in 1 h.	No
P042	One munition falls off the conveyor and detonates in the ECV, caused by process upset or improper loading.	Yes
P043	Same as P041 with added fire.	No
P044	Same as P042 with failure propagating to other munitions due to fragments.	No
P045	A process upset results in spill of agent inventory in ECR.	No
P046	Same as P045 with fire.	No
P047	Same as P045 with detonation.	No
P048	A punched munition falls off the BSA conveyor. Bulk drain station did not drain the munitions before sending it to the BSA, so that a spill occurs.	No
P049	Same as P048 with fire.	No
P050	Large spill (contents of agent collection tank) in TOX cubicle due to pipe failure (528 gal).	No
P051	Small spill (typically less than 50 gal) in TOX cubicle due to pipe failure.	No
P052	Same as P051 with fire.	No

Other sequences identified are summarized in Tables A-1, A-2, and A-3. These deal with furnace/incinerator events. The event trees corresponding to these sequences are in Section 7.1. None of the sequences in these tables was considered for detailed analysis.

TABLE A-1
EVENTS CONSIDERED FOR THE DEACTIVATION FURNACE SYSTEM

Event	Description
Stop munitions feed (DFS-SMF)	Failure on this event tree branch implies that feed of drained rockets or mines to the DFS is not discontinued, given that a shutdown signal occurs.
Ventilation system (DFS-VENT)	This branch point represents the failures of the ventilation system to provide filtered air to the DFS pump. (See Section 7.1 for the fault tree.)
Stop fuel (DFS-SFA)	Failure of this event tree branch implies that the natural gas supply line to the burner in the DFS retort is not isolated, given that a shutdown signal occurs. If ventilation to the room has failed, operator recovery is permitted to prevent a possible room explosion. (See Section 7.1 for the fault tree.)
Explosion does not occur (DFS-EXP)	Failure of this branch implies that a natural gas explosion has occurred in the DFS room. For the situation in which ventilation succeeds, the size of this explosion is the size of a DFS furnace explosion. For the case in which room ventilation has failed, the explosion is the size of a DFS room explosion. The probability was subjectively estimated.
Explosion contained (DFS-CONT)	Failure of this branch implies that the DFS room structure has been breached by an explosion. The probability was subjectively estimated.

TABLE A-2
EVENTS CONSIDERED FOR THE LIQUID INCINERATOR (LIC)

Event	Description
Ventilation system (LIC-VENT)	This branch point represents the failure of the ventilation system to provide air to the LIC room. (The fault tree is in Section 7.1.)
Stop agent feed (LIC-SAF)	This branch point represents both the ACS and the operator failing to shut off the agent feed and failing to recognize that the feed is not shut off. Different time periods and therefore different recovery probabilities apply for different scenarios. (The fault tree is in Section 7.1.)
Shutdown PAS (LIC-SPAS)	This branch point represents both the ACS and the operator failing to stop flow through the PAS and failing to recognize that flow continues. (The fault tree is in Section 7.1.)
Stop fuel to burners (LIC-SFF)	The branch point represents both the ACS and the operator failing to shut off the fuel within 15 min and failing to recognize that the fuel is not shut off. This event applies to the PCC and the AB. (The fault tree is in Section 7.1.)
Avoid explosion (LIC-EXP)	This branch represents ignition/detonation of accumulated fuel/air or agent/air mixtures. The probability was subjectively assigned.
Structure contains explosion (LIC-CONT)	This branch represents failure of the LIC room to contain an explosion. The probability was subjectively assigned.
Stop fuel to LIC-PCC burner (LIC-SFP)	This branch point represents both the ACS and the operator failing to shut off fuel to the LIC PCC burner within 15 min and failing to recognize that the fuel is not shut off. (The fault tree is in Section 7.1.)

TABLE A-3
EVENTS CONSIDERED FOR THE METALS PARTS FURNACE (MPF)

Event	Description
MPF-1 Tree	
Ventilation System (MPF-VENT)	This branch point represents the failure of the exhaust system to provide filtered air to the MPF room. (See Section 7.1 for the fault tree.)
Stop fuel (MPF-SFA)	Failure of the branch point implies that the natural gas supply to one or more burners in the MPF has not been isolated. If room ventilation has failed, operator recovery is permitted to prevent a possible room explosion. (See Section 7.1 for the fault tree.)
Explosion avoided (MPF-EXP)	Failure of this branch point implies that natural gas explosion has occurred in the MPF room. For this situation in which ventilation succeeds, the size of the explosion is the size of the DFS furnace explosion. For the case in which room ventilation has failed, the explosion is the size of an MPF room explosion. The probability was subjectively estimated.
Explosion contained (MPF-CONT)	Failure of this branch point implies that the MPF room structure has been breached by the MPF explosion. The probability was subjectively estimated.
MPF-2 Tree	
Explosion does not occur (MPF-EX)	This branch point involves the undrained munition exploding in the MPF. The probability was subjectively estimated.
MPF room and vent integrity maintained (MPF-INT)	This branch point involves damage to the MPF room or vent such that agent in the room is released to the atmosphere. The probability was subjectively estimated.

ACCIDENT SEQUENCES FOR HANDLING (ONSITE)

Sequence ID	Sequence Description	Considered for Further Analysis
HO1	Drop of bare pallet or single item at storage area.	Yes
HO2	Forklift collision with short duration fire at storage area involving bare munitions.	Yes
HO3	Forklift tine accident involving bare munitions at storage area.	Yes
HO4	Forklift collision accident without fire at storage area involving bare munitions.	Yes
HO5	Drop of onsite container.	Yes
HO6	Forklift collision with short duration fire during handling of onsite container.	Yes
HO7	Forklift collision without fire during handling of onsite container.	Yes
HO8	Drop of offsite container.	No
HO9	Collision accident with short duration fire during handling of offsite container.	No
HO10	Collision accident without fire during handling of offsite container.	No
HO11	Drop of bare palletized munition leads to detonation.	Yes
HO12	Forklift collision accident at storage area leads to detonation of burstered munition.	Yes
HO13[a]	Forklift collision accident without fire at maintenance facility.	No
HO14	Forklift tine accident involving munitions in onsite container.	No
HO15[a]	Improper valve replacement on ton container.	No
HO16[a]	Drop of single munition in maintenance facility.	No

ACCIDENT SEQUENCES FOR HANDLING (ONSITE) (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
H017	Drop of pallet containing a leaking munition during leaker isolation operations at LPF.	No
H018	Drop of single leaking munition in vapor containment room of leakers processing facility.	No
H019	Forklift tine puncture during leaker isolation operations.	No
H020	Collision accident with short duration fire during handling of leaking munition (munition in pallet).	No
H021	Collision accident without fire during handling of leaker.	No
H022	Drop of munition in onsite container leads to detonation.	Yes
H023	Drop of munition in offsite container leads to detonation.	No
H024	Collision accident during munition handling in onsite container leads to detonation due to impact.	Yes
H025	Collision accident during munition handling in offsite container leads to detonation due to impact.	No
H026	Collision accident in onsite container with prolonged fire leads to thermal detonation.	Yes
H027	Collision accident in offsite container with prolonged fire leads to thermal detonation.	No
H028[b]	Drop of single munition at maintenance facility leads to detonation.	No
H029	Drop of pallet containing leaker leads to detonation.	No
H030	Drop of single leaking munition leads to detonation.	No

ACCIDENT SEQUENCES FOR HANDLING (ONSITE) (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
H031	Collision accident involving a leaker leads to detonation due to impact.	No
H032	Failure to detect a leak in the offsite container.	No

[(a)]These scenarios were originally identified for the handling of 4.2-in. mortars and 10-5mm cartridges during movement from storage to a maintenance facility (and back) for propellant separation.

[(b)]Leakers developing during transportation from storage igloo to holding area.

ACCIDENT SEQUENCES FOR HANDLING (FACILITY)

Sequence ID	Sequence Description	Considered for Further Analysis
HF1	Munition dropped during movement from the MHI to the MDB.	Yes
HF2	Bare single munition dropped during handling inside the MDB.	Yes
HF3	Forklift collision accident with short duration fire during handling from MHI to MDB.	Yes
HF4	Forklift tine accident during handling from MHI to MDB.	Yes
HF5	Forklift collision accident with prolonged fire during handling from MHI to MDB leads to detonation.	Yes
HF7	Collision accident without fire during movement from the MHI to the MDB.	Yes
HF8	Munition dropped inside the MDB (in onsite container).	Yes
HF9	Forklift tine accident occurs inside the MDB.	Yes
HF10	Forklift collision accident without fire inside the MDB.	Yes
HF11	Munition pallet dropped during movement from the MHI to the MDB leads to detonation.	Yes
HF12	Bare single munition dropped during handling inside the MDB leads to detonation.	Yes
HF13	Palletized munition in onsite container dropped during handling inside the MDB leads to detonation.	Yes
HF14	Collision accident from MHI to MDB leads to detonation due to impact.	Yes

ONSITE TRANSPORT ACCIDENT SEQUENCES

Sequence ID	Sequence Description	Considered for Further Analysis
VOXYZ001	A munitions vehicle collision/overturn occurs and crush forces fail the agent containment.	Yes
VOXYZ002	A munitions vehicle collision/overturn occurs and impact forces fail the agent containment.	No
VOXYZ003	A munitions vehicle collision/overturn occurs and puncture forces fail the agent containment.	Yes
VOXYZ004	A munitions vehicle accident with fire occurs, causing detonation of burstered munitions. Ignition of the propellant by a probe could also detonate the burster of a cartridge and the burster of a rocket could be detonated by impact-induced ignition of the rocket propellant.	Yes
VOXYZ005	A munitions vehicle accident with fire occurs, causing nonburstered munitions to fail.	Yes
VOXYZ006	An aircraft crashes on a munitions vehicle. No fire occurs; impact forces the agent containment.	Yes
VOXYZ007	An aircraft crashes on a munitions vehicle. Fire occurs, but impact forces fail the agent containment.	Yes
VOXYZ009	A severe earthquake occurs, causing a munitions vehicle accident and crush forces fail the agent containment.	Yes
VOXYZ010	A severe earthquake occurs, causing a munitions vehicle accident and impact forces fail the agent containment.	No
VOXYZ011	A severe earthquake occurs, causing a munitions vehicle accident and puncture forces fail the agent containment.	Yes
VOXYZ012	A severe earthquake occurs, causing a munitions vehicle accident and fire detonates burstered munitions.	Yes
VOXYZ013	A severe earthquake occurs, causing a munitions vehicle accident and fire fails nonburstered munitions.	Yes

ONSITE TRANSPORT ACCIDENT SEQUENCES (Continued)

Sequence ID	Sequence Description	Considered for Further Analysis
VOXYZ014	A tornado occurs, generating a missile or causing a truck overturn and mechanical forces fail agent containment.	Yes
VOXYZ015	A truck collision/overturn occurs generating undue mechanical forces which cause detonation of burstered munitions.	Yes

APPENDIX B
SENSITIVITY ANALYSIS

3.0 INTRODUCTION

Several accident scenarios were identified that could result in a significant release of agent to the environment during demilitarization operations at CONUS sites. These scenarios include:

- TOX Area Fire
- BSA Area Fire
- ECV Area Fire
- Carbon Filter Fire
- Carbon Filter Desorption
- Continued Agent Feed in Non-operating LIC
- PAS Agent Scrubbing
- Feed Full Ton Container into MPF.

Several other scenarios involving munition detonation were identified but not evaluated in favor of providing documentation for the sensitivity analyses. Results from the sensitivity analysis are described for each scenario as follows.

3.1 Results from Sensitivity Analyses

3.1.1 TOX Area Fire. The TOX Area fire involves the following sequence of events:

(1) Rupture of filled 500-gallon agent storage tank in TOX Area
(2) Ignition of agent spill
(3) Failure of TOX fire suppression system
(4) Fire vaporizes agent which is vented from the TOX to the carbon filters.

Undecomposed agent can be released to the environment through the filters if the agent flow rate is sufficiently high, the filters approach saturation and/or the filter inlet gas temperature is high. The sensitivity

of the magnitude of agent released to the environment was therefore considered on the following variables:

- Residence time of volatilized agent in the TOX
- Fire size (directly related to undecomposed agent flow rate)
- Combustion efficiency (directly related to undecomposed agent flow rate)
- Capacity of carbon to absorb agent
- Gas temperature at filter inlet.

In an agent fire, heat returned to the pool of burning liquid by convective and radiative mechanisms is used to volatilize agent. Part of the volatilized agent is combusted with the remainder potentially vented from the area. Residence time in the TOX of volatilized agent that is not combusted was included in the sensitivity analysis because the fire may raise the temperature to a point where thermal decomposition of the volatilized agent could occur. As a worst case, a 1-second residence time was assumed. This is equivalent to the volatilized agent traveling a distance of about four inches prior to entering the TOX ventilation exhaust duct. Residence times of 2, 5, 10, and 14.3 seconds were also evaluated. The 14.3-second residence time is the most credible case and would involve a fire on the floor directly below the exhaust duct (5-feet above the floor). This is possible because a 500-gallon spill of agent will fill the 500-gallon sump in the TOX and completely cover the TOX floor.

As discussed in detail in the calculation summaries given in Appendix A pages A1 through A28, the fire size will be limited by the ventilation flow rate. The worst case, i.e. the largest fire, will result when the fire burns a sufficient amount of agent to reduce the oxygen concentration to the minimum level required for combustion. A second case involves a fire size equivalent to the TOX sump area. Another fire size is where the release of undecomposed agent from the TOX area reaches a maximum for a particular residence time. This fire size, calculated by trial and error, is where the agent vaporization rate is relatively high while the agent combustion rate and, in turn, the TOX temperature is sufficiently low such that thermal decomposition of agent is not appreciable.

The combustion efficiencies evaluated were 50, 75 and 100 percent. It is important to note that a 100 percent combustion efficiency implies that all the agent involved in combustion is converted to CO_2, H_2O, P_2O_5, etc. so that the entire heating value of the agent is generated. A combustion efficiency of less than 100 percent implies that intermediate combustion products formed so that the entire heating value of the agent was not generated. Agent can be volatilized but not combusted for any combustion efficiency including 100 percent. This could occur if the part of the agent is directed away from the flames as it is volatilized.

The capacity of the carbon to adsorb agent was varied from 0.05 lb agent/lb carbon as a worst case to 0.2 lb agent/lb carbon. The 0.2 lb capacity is still conservative when compared with the capacities of 0.37 lb HD/lb carbon, 0.298 lb VX/lb carbon, and 0.318 lb GB/lb carbon given in Reference 1. These capacities are for G210 coconut-derived, non-whetlerized activated carbon, which is similar to the activated carbon used at CAMDS.

The gas temperature at the filter inlet was varied from 100 F up to a temperature calculated from heat balances. The calculated temperature is the worst case because it does not incorporate all heat losses from the gas during traversal between the TOX Area and the filters. The rate and degree of adsorption is known to be exponentially and inversely proportional to temperature. Thus, a small increase in temperature may cause a significant decrease in adsorption efficiency.

Table 1 gives a summary of agent releases for various fire sizes and combustion efficiencies. The maximum fire duration given in Table 1 was estimated as follows. The maximum fire duration for large fires which reduce the oxygen concentration in the TOX to the minimum required for combustion is the time required for an operator to close the inlet dampers to the TOX, thereby shutting off the oxygen supply. As shown in Figure 1, approximately 15 minutes are required for a 99 percent probability that an operator will respond to close the TOX inlet dampers. This includes a 5 minute period in which the operator will attempt to start the fire protection system in the TOX. In cases where the fire size is not at a maximum, additional time is required for consumption of the oxygen remaining in the TOX after the dampers are shut. The fire will continue until the

TABLE 1. SUMMARY OF TOX AREA FIRE CALCULATIONS[a]

Fire Size and Combustion Efficiency are Varied

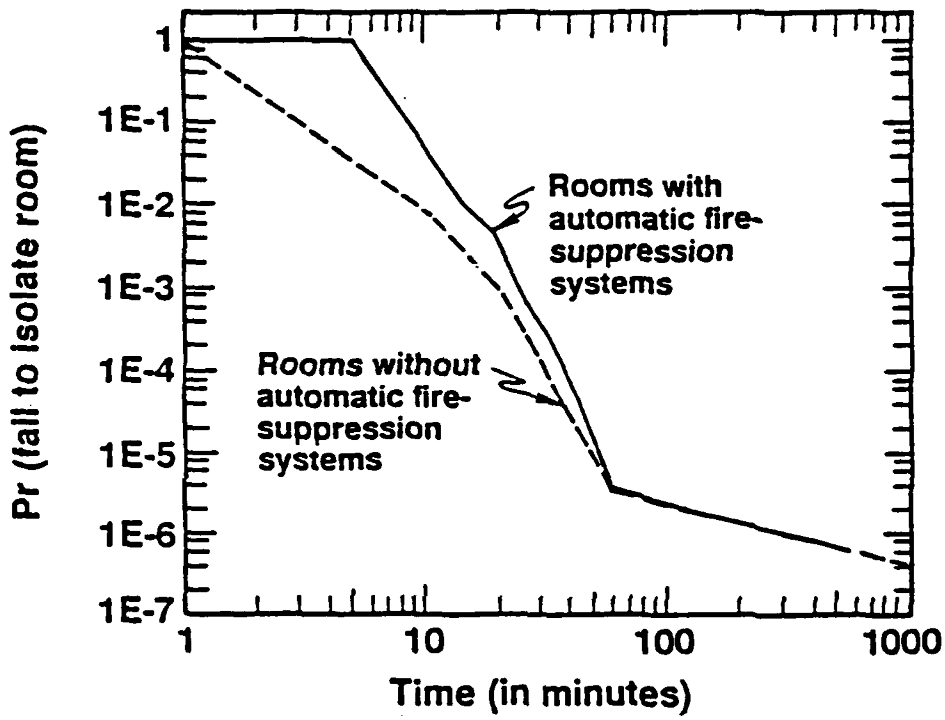
Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	Sump[b]	100	2	0.0092	0.1959	22
HD	60	100	(c)	< 0.0001	< 0.0001	15
HD	Sump	75	4	0.0026	0.2103	25
HD(d)	21	75	4	0.0028	0.2814	25
HD	80	75	(c)	< 0.0001	< 0.0001	15
HD	Sump	50	34	< 0.0001	0.0009	33
HD	121	50	(c)	< 0.0001	< 0.0001	15
GB	Sump	100	3	0.0630	2.7654	20
GB	51	100	(c)	< 0.0001	< 0.0001	15
GB	Sump	75	5	0.0167	6.2826	24
GB(d)	21	75	2	0.0229	6.4324	23
GB	68	75	(c)	< 0.0001	< 0.0001	15
GB	Sump	50	10	0.0002	0.6728	30
GB	103	50	(c)	< 0.0001	< 0.0001	15
VX	Sump	100	(c)	< 0.0001	< 0.0001	15
VX	21	100	(c)	< 0.0001	< 0.0001	15
VX(d)	14	75	> 60	< 0.0001	< 0.0001	18
VX	Sump	75	> 60	< 0.0001	< 0.0001	16
VX	28	75	(c)	< 0.0001	< 0.0001	15
VX	Sump	50	(c)	< 0.0001	< 0.0001	19
VX	42	50	(c)	< 0.0001	< 0.0001	15

(a) Carbon capacity = 0.05 lb agent/lb carbon, gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the TOX area = 1 second.

(b) Sump area = 20 square feet.

(c) The fire does not release agent from the TOX area.

(d) Worst-case fire area/combustion efficiency combination.



Time	Pr (fail to isolate by X mins) With System	Without System
by 5 mins.	1.0	4E-2
by 10 mins.	4E-2	1E-2
by 15 mins.	1E-2	4E-3

Figure 1. Operator Times Versus Probabilities for Failure to Close Dampers

minimum oxygen level required for combustion is reached, at which point the fire is assumed to self-extinguish.

Results indicate that both fire size and combustion efficiency have a significant effect on the magnitude of agent released to the environment. The worst cases are 75 percent combustion efficiency/21 sq. ft. fire for HD and for GB. No combination of the variables allowed a significant release of VX.

Table 2 gives a summary of agent releases for various gas residence times in the TOX. The most credible residence time of 14.3 seconds results in a significantly lower agent release. The 14/75 fire size/combustion efficiency combination is the worst case for a 14.3-second residence time. This trend is explained later for the BSA area fire.

Table 3 gives a summary of agent releases for variable carbon capacities. The more credible capacity of 0.2 lb agent/lb carbon significantly reduced the amount of agent released by at least an order of magnitude.

Table 4 gives a summary of agent releases for variable gas temperatures at the filter inlet. The lower temperatures resulted in significantly lower agent releases due to the strong dependence of the adsorption rate constant on temperature.

The worst-case and most-credible-case agent releases for the TOX Area fire are given in Table 5. The most credible case was selected based on a 14.3-second residence time for the volatilized agent in the TOX, a carbon capacity of 0.05 lb agent/lb carbon (worst case), filter inlet gas temperature calculated from heat balances (worst case), and the worst case fire size/combustion efficiency combination. The worst case was as above except for a 1-second residence time. The most credible case is still very conservative because:

- The selected agent capacity of carbon is below that obtained during actual agent tests
- Filter bank inlet gas temperature will be lower than the calculated temperature when all heat losses are taken into account
- As described in the calculation summary of Appendix A, worst-case assumptions were used whenever information was unavailable.

TABLE 2. SUMMARY OF TOX AREA FIRE CALCULATIONS[a]

Residence Time of Fire Products in TOX Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Residence Time (sec.)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	20/75	1	2	0.0092	0.1959	25
HD	20/75	2	5	0.0015	0.1168	25
HD	20/75	5	7	0.0006	0.0291	25
HD	20/75	10	12	0.0002	0.0059	25
HD[b]	20/75	14.3	19	< 0.0001	0.0021	25
HD[b]	14/75	14.3	21	< 0.0001	0.0058	31
GB	21/75	1	2	0.0229	0.4324	23
GB	21/75	2	2	0.0151	2.8776	23
GB	21/75	5	3	0.0053	0.4355	23
GB	21/75	10	5	0.0014	0.0581	23
GB[b]	21/75	14.3	7	0.0005	0.0176	23
GB[b]	14/75	14.3	9	0.0002	0.1613	29
VX	14/75	1	> 60	< 0.0001	< 0.0001	18
VX	14/75	2	> 60	< 0.0001	< 0.0001	18
VX	14/75	5	> 60	< 0.0001	< 0.0001	18
VX	14/75	10	> 60	< 0.0001	< 0.0001	18
VX[b]	14/75	14.3	> 60	< 0.0001	< 0.0001	18
VX[b]	10/75	14.3	> 60	< 0.0001	< 0.0001	21

(a) Carbon capacity = 0.05 lb agent/lb carbon. The filter inlet gas temperature calculated by heat balances. Worst case fire size/combustion efficiency combinations shown for GB and VX

(b) Most credible residence time of the fire products in the TOX area.

TABLE 3. SUMMARY OF TOX AREA FIRE CALCULATIONS[(a)]

Carbon Capacity Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Carbon Capacity (lb agent/ lb carbon)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	21/75	0.2	4	0.0016	0.0214	25
HD	21/75	0.05	4	0.0028	0.2814	25
HD[(b)]	14/75	0.2	50	< 0.0001	0.0004	31
HD[(b)]	14/75	0.05	21	< 0.0001	0.0050	31
GB	21/75	0.2	2	< 0.0097	0.1452	23
GB	21/75	0.05	2	0.0229	0.4324	23
GB[(b)]	14/75	0.2	5	0.0001	0.0025	29
GB[(b)]	14/75	0.05	9	0.0002	0.1613	29
VX	14/75	0.2	> 60	< 0.0001	< 0.0001	18
VX	14/75	0.05	> 60	< 0.0001	< 0.0001	18
VX[(b)]	14/75	0.2	> 60	< 0.0001	< 0.0001	21
VX[(b)]	14/75	0.05	> 60	< 0.0001	< 0.0001	21

(a) Gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the TOX area = one second. Worst-case fire size/combustion efficiency combinations shown.

(b) Gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the TOX area = 14.3 seconds. Worst-case fire size/combustion efficiency combinations shown.

TABLE 4. SUMMARY OF TOX AREA FIRE CALCULATIONS[a]

Filter Inlet Gas Temperature Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Filter Inlet Gas Temperature (F)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	21/75	100	18	< 0.0001	0.0092	25
HD	21/75	114	4	< 0.0028	0.2814	25
HD[b]	14/75	100	32	< 0.0001	0.0009	31
HD[b]	14/75	105	21	< 0.0001	0.0058	31
GB	21/75	100	9	0.0001	0.0062	23
GB	21/75	110	2	0.0229	0.4324	23
GB[b]	14/75	100	17	< 0.0001	0.0385	29
GB[b]	14/75	106	9	0.0002	0.1613	29
VX	14/75	100	> 60	< 0.0001	< 0.0001	18
VX	14/75	120	> 60	< 0.0001	< 0.0001	18
VX[b]	14/75	100	> 60	< 0.0001	< 0.0001	21
VX[b]	14/75	120	> 60	< 0.0001	< 0.0001	21

(a) Carbon capacity = 0.05 lb agent/lb carbon. The residence time of the fire products in the TOX area = 1 second. Worst-case fire size/combustion efficiency combinations shown.

(b) Carbon capacity = 0.05 lb agent/lb carbon. The residence time of the fire products in the TOX area = 14.3 seconds.
Worst-case fire size/combustion efficiency combinations shown.

TABLE 5. TOX AREA FIRE WORST CASE/MOST CREDIBLE CASE AGENT RELEASES

WORST CASE [a]

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	21	75	4	0.0028	0.2814	25
GB	21	75	2	0.0229	0.4324	23
VX	14	75	> 60	< 0.0001	< 0.0001	17

MOST CREDIBLE CASE [b]

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	14	75	21	< 0.0001	0.0056	31
GB	14	75	9	0.0002	0.1613	29
VX	10	75	> 60	< 0.0001	< 0.0001	21

(a) Carbon capacity = 0.05 lb agent/lb carbon, filter inlet gas temperature calculated from heat balance. The residence time of the fire products in the TOX area = 1 second.

(b) Carbon capacity = 0.05 lb agent/lb carbon, filter inlet gas temperature calculated from heat balance. The residence time of the fire products in the TOX area = 14.3 seconds. Worst-case fire size/combustion efficiency used.

It is important to note that a spill significantly less than 500 gallons can cause the worst-case or most-credible-case agent releases to be achieved because the fire areas for these events are approximately the same as or less than the TOX sump area of 20 sq. ft.

3.1.2 BSA Area Fire. The BSA Area fire involves the following sequence of events:

(1) Contents of a filled ton container are spilled on the floor in the Buffer Storage Area.

(2) Spilled agent is ignited.

(3) Fire vaporizes agent, which is vented from the BSA to the carbon filters.

The variables described in the TOX Area fire were evaluated for the BSA Area fire. A summary of the calculations is given in Appendix A, pages A29 through A35.

Table 6 gives a summary of agent releases during a BSA fire for various fire sizes and combustion efficiencies. The size of an agent release is most dependent on fire size. Although large fires resulted in large rates of undecomposed agent being generated, the resultant temperature in the BSA (over 1000 F in some cases) would cause significant thermal decomposition of the agent. However, in some cases the high rate of undecomposed agent being expelled from the TOX could overwhelm the carbon filters due to limitations in the adsorption kinetics. Combustion efficiency had a significant effect on agent release for all cases, with the worst case being a 100 percent combustion efficiency. The much larger agent releases in the BSA Area as compared with the TOX Area are due to the availability of more ventilation air in the BSA, thereby allowing combustion and volatilization of agent at a more rapid rate.

Table 7 gives a summary of agent releases during a BSA fire for various residence times of fire products in the BSA. The most credible residence time of 35.6 seconds is equivalent to a fire directly beneath the BSA exhaust duct. A worst-case residence time was assumed to be 1 second.

For a particular residence time, the agent released is dependent upon fire size. As shown in Figure 2, the amount of agent released

TABLE 6. SUMMARY OF BSA AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Fire Size and Combustion Efficiency are Varied

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	Sump[b]	100	> 60	< 0.0001	0.0004	62
HD[g]	18	100	1	13.8317	75.2400	19
HD	77	100	(d)	< 0.0001	< 0.0001	(c)
HD	Sump	75	(d)	< 0.0001	< 0.0001	80
HD	103	75	(d)	< 0.0001	< 0.0001	(c)
HD	Sump	50	(d)	< 0.0001	< 0.0001	127
HD	156	50	(d)	< 0.0001	< 0.0001	(e)
GB	Sump	100	3	0.0050	0.3593	60
GB[g]	18	100	1	29.8980	168.7586	19
GB	66	100	(d)	< 0.0001	< 0.0001	(e)
GB	Sump	75	> 60	< 0.0001	< 0.001	70
GB	89	75	(d)	< 0.0001	< 0.0001	(e)
GB	Sump	50	> 60	< 0.0001	< 0.001	119
GB	135	50	(d)	< 0.0001	< 0.0001	(f)
VX	Sump	100	> 60	< 0.0001	< 0.0001	30
VX[g]	11	100	3	0.0138	0.1391	16
VX	26	100	(d)	< 0.0001	< 0.0001	10
VX	Sump	75	(d)	< 0.0001	< 0.0001	43
VX	36	75	(d)	< 0.0001	< 0.0001	10
VX	Sump	50	(d)	< 0.0001	< 0.0001	79
VX	54	50	(d)	< 0.0001	< 0.0001	10

(a) Carbon capacity = 0.05 lb agent/lb carbon, gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the BSA area = 1 second.
(b) Sump area = 4 square feet.
(c) The fire burns to completion within 8 minutes.
(d) The fire does not release agent from the BSA area.
(e) The fire burns to completion within 7 minutes.
(f) The fire burns to completion within 8 minutes.
(g) Worst-case fire area/combustion efficiency combination.

TABLE 7. SUMMARY OF BSA AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Residence Time of Fire Products in BSA Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Residence Time (sec.)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	10/100	1	1	13.8317	76.2400	19
HD	10/100	2	1	10.0869	53.5465	19
HD	10/100	5	1	5.1578	20.6459	19
HD	10/100	10	1	0.9675	4.7516	19
HD	10/100	35.6	7	0.0007	0.0035	19
HD	10/100	35.6	1	0.4758	6.8254	29
GB	10/100	1	1	29.8980	168.7586	19
GB	10/100	2	1	23.9972	133.3433	19
GB	10/100	5	1	12.7504	68.0816	19
GB	10/100	10	1	4.7153	24.2035	19
GB	10/100	35.6	1	0.0382	0.1903	19
GB	11/100	35.6	1	2.2634	28.8833	26
VX	11/100	1	3	0.0138	0.1391	16
VX	11/100	2	3	0.0161	0.0941	16
VX	11/100	5	3	0.0044	0.0350	16
VX	11/100	10	5	0.0013	0.0092	16
VX	11/100	35.6	> 60	< 0.0001	< 0.0001	16
VX	7/100	35.6	> 60	< 0.0001	< 0.0001	20

(a) Carbon capacity = 0.05 lb agent/lb carbon. The filter inlet gas temperature calculated from heat balances. Worst-case fire size/combustion efficiency combinations shown.

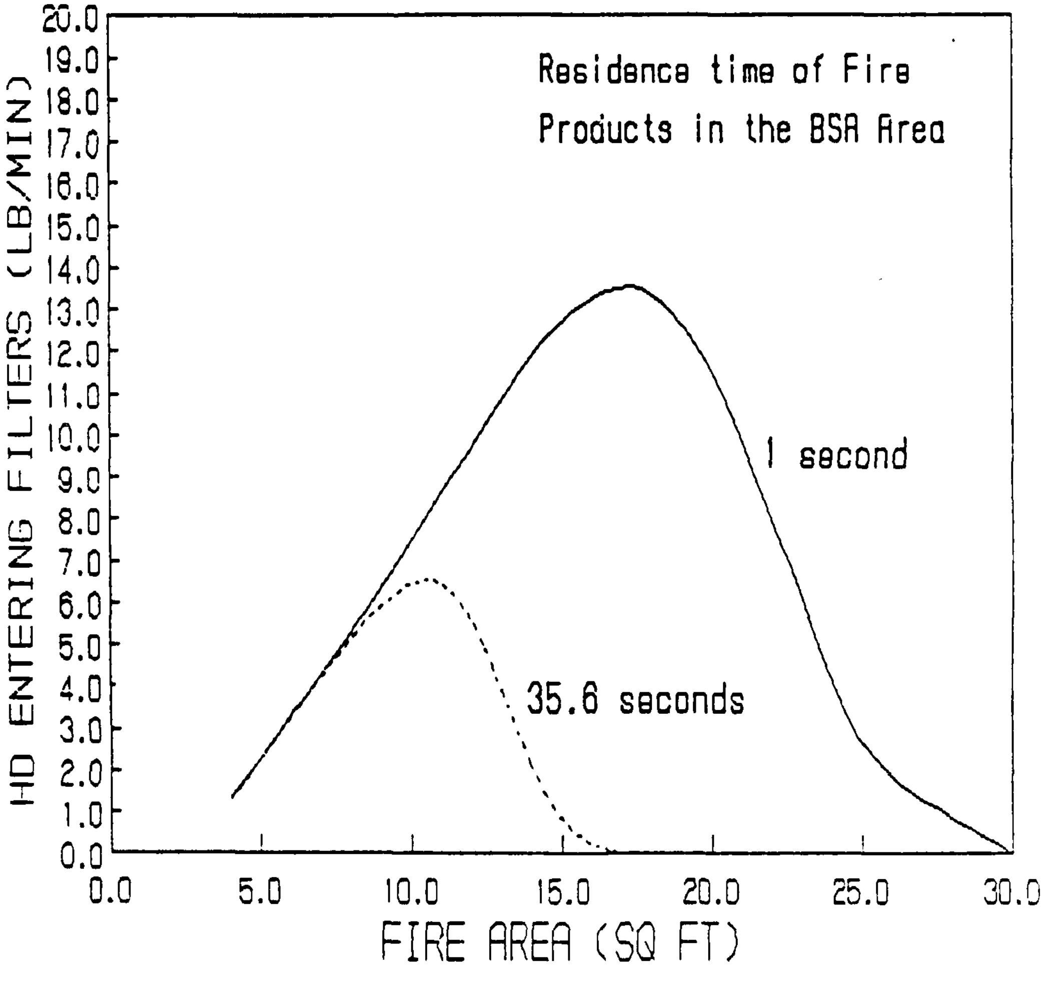


Figure 2. Effect of Residence Time on Maximum Quantity of Agent Entering Filters during the BSA Fire

increases as the fire size increases, reaches a maximum, and then falls to zero. As the fire size is increased the amount of volatilized agent that is not combusted increases in proportion to the fire size. However, increasing the fire size causes the temperature in the area of the fire to increase such that thermal decomposition becomes significant. Because thermal decomposition is exponentially related to fire size through temperature, the amount of undecomposed agent decreases as the fire size increases. These trends are illustrated in Figure 3.

The fire size which gives the maximum agent release decreases as the residence time increases, as shown in Figure 2. This is because as the residence time is increased the amount of undecomposed agent released decreases for a particular fire size. Thus, smaller fires which result in a lower temperature and hence, lower degree of thermal decomposition, would favor generation of more undecomposed agent than larger fires. It is important to note that the worst-case fire size/combustion efficiency was calculated by trial and error for each worst-case and most-credible-case residence time for the TOX, BSA and ECV fire scenarios.

Table 8 gives a summary of agent release during a BSA fire for various carbon capacities. The carbon capacity has only a slight effect on the amount of agent released within the range of capacities evaluated. This is because the high temperature of the gases entering the filters makes adsorption unfavorable.

Table 9 gives a summary of agent releases during a BSA fire for various gas temperature at the filter inlet. The lower gas temperature had a significant effect on agent release amounting to a reduction of between three and five orders of magnitude.

The worst-case and most-credible-case agent releases for the BSA Area fire scenarios are given in Table 10. The most credible case was based on a 35.6-second residence time for the volatilized agent in the BSA, a carbon capacity of 0.05 lb agent/lb carbon (worst case), a filter inlet gas temperature calculated from heat balances (worst case), and the worst-case fire size/combustion efficiency combination. The worst case is as above except for a 1-second residence time. The most credible case is still very conservative for similar reasons to those given in the TOX area fire section.

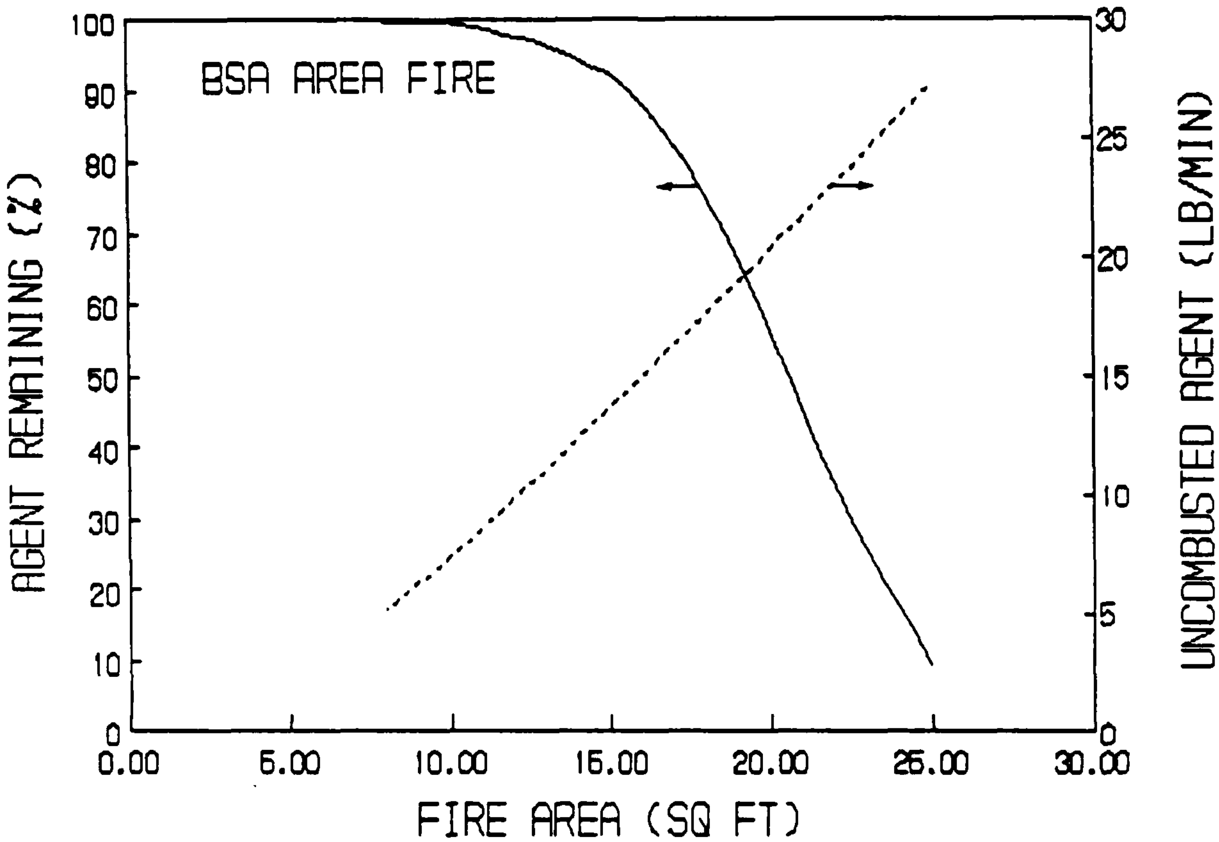


Figure 3. Variance of Thermal Decomposition of Agent and Generation Rate of Undecomposed Agent with Fire Area for the BSA Fire

TABLE 8. SUMMARY OF BSA AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Carbon Capacity Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Carbon Capacity (lb agent/ lb carbon)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	10/100	0.2	1	12.7931	61.2925	19
HD	10/100	0.05	1	13.8317	75.2408	19
HD[b]	10/100	0.2	1	0.4213	3.9583	29
HD[b]	10/100	0.05	1	0.4758	6.8254	29
GB	10/100	0.2	1	26.8097	128.6018	19
GB	10/100	0.05	1	29.8980	168.7586	19
GB[b]	11/100	0.2	1	1.9434	15.7784	26
GB[b]	11/100	0.05	1	2.2634	28.8833	26
VX	11/100	0.2	3	0.0163	0.0666	16
VX	11/100	0.05	3	0.0138	0.1391	16
VX[b]	7/100	0.2	> 60	< 0.0001	< 0.0001	20
VX[b]	7/100	0.05	> 60	< 0.0001	< 0.0001	20

(a) Gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the BSA area = 1 second. Worst-case fire size/combustion efficiency combinations shown.

(b) Same as in (a) except the residence time of the fire production in the BSA area = 35.6 seconds.

TABLE 9. SUMMARY OF BSA AREA FIRE CALCULATIONS (TON CONTAINER)[(a)]

Filter Inlet Gas Temperature Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Filter Inlet Gas Temperature (F)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	10/100	100	14	< 0.0001	0.0074	19
HD	10/100	179	1	13.0317	75.2400	19
HD [(b)]	10/100	100	30	< 0.0001	0.0009	29
HD [(b)]	10/100	143	1	0.4750	0.0254	29
GB	10/100	100	7	0.0003	0.0973	19
GB	10/100	103	1	29.0900	100.7500	19
GB [(b)]	11/100	100	17	< 0.0001	0.0144	20
GB [(b)]	11/100	152	1	2.2034	20.0033	20
VX	11/100	100	> 60	< 0.0001	< 0.0001	10
VX	11/100	200	3	0.0130	0.1391	10
VX [(b)]	7/100	100	> 60	< 0.0001	< 0.0001	20
VX [(b)]	7/100	174	> 60	< 0.0001	< 0.0001	20

(a) Carbon capacity = 0.05 lb agent/lb carbon. The residence time of the fire products in the BSA area = 1 second. Worst-case fire size/combustion efficiency combinations shown.

(b) Same as in (a) except the residence time of the fire products in the BSA area = 35.0 seconds.

TABLE 10. BSA AREA FIRE WORST CASE/MOST CREDIBLE CASE AGENT RELEASES

WORST CASE [(a)]

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	18	100	1	13.8317	75.2488	19
GB	18	100	1	29.8980	168.7586	19
VX	11	100	3	0.0138	0.1391	16

MOST CREDIBLE CASE (b)

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	10	100	1	0.4758	6.8254	29
GB	11	100	1	2.2634	28.8833	26
VX	7	100	> 60	< 0.0001	< 0.0001	28

(a) Carbon capacity = 0.05 lb agent/lb carbon, filter inlet gas temperature calculated from heat balances. The residence time of the fire products in the BSA area = 1 second.

(b) Carbon capacity = 0.05 lb agent/lb carbon, filter inlet gas temperature calculated from heat balances. The residence time of the fire products in the BSA area = 35.6 seconds.

It is important to note that the worst-case agent release would involve a TC that gradually leaks agent rather than a ruptured TC that spills the entire contents at once. The size of the fire following ignition of spilled agent from a leaking TC may be at the worst-case conditions depending upon the leak rate and spill configuration. However, ignition of the spill from a ruptured TC would probably cause an initial large fire that, because of thermal decomposition, releases an insignificant amount of agent to the environment. This large fire would rapidly consume agent and decrease in size until it is restricted to the sump at which time low levels of agent would be released to the environment. The fire would rapidly pass through the zone where large amounts of undecomposed agent are generated. As an approximation, agent released from a fire in the case of a ruptured TC can be taken as being equivalent to a sump fire for the entire fire duration.

3.1.3 ECV Area Fire. The ECV Area fire involves the following sequence of events:

(1) Contents of a filled ton container are spilled on the floor in the Explosive Containment Vestibule. The location assumed is given in Appendix A.

(2) Spilled agent is ignited.

(3) Fire vaporizes agent which is vented from the ECV area to the carbon filters.

The variables described in the TOX area fire were evaluated for the ECV area fire. A summary of the calculations is given in Appendix A, pages A36 through A41.

Table 11 gives a summary of agent releases during an ECV fire for varying fire size and combustion efficiency. As in the case of the BSA Area fire, both the fire size and combustion efficiency have a significant effect on the amount of agent released. The worst cases are 100 percent combustion efficiency/11 sq. ft. fire size for HD and GB. No significant VX releases were observed for any combination of fire size and combustion efficiency.

Table 12 gives a summary of agent releases during an ECV fire for various residence times of volatilized agent in the ECV. The most credible

TABLE 11. SUMMARY OF ECV AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Fire Size and Combustion Efficiency Varied

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	Sump[b]	100	> 60	< 0.0001	< 0.0001	30
HD[c]	11	100	4	0.0022	0.0268	10
HD	40	100	(e)	< 0.0001	< 0.0001	10
HD	Sump	75	> 60	< 0.0001	< 0.0001	39
HD	64	75	(e)	< 0.0001	< 0.0001	10
HD	Sump	50	> 60	< 0.0001	< 0.0001	69
HD	90	50	(e)	< 0.0001	< 0.0001	10
GB	Sump	100	> 60	< 0.0001	< 0.0001	30
GB[c]	11	100	2	0.0118	0.1780	10
GB	41	100	(e)	< 0.0001	< 0.0001	10
GB	Sump	75	> 60	< 0.0001	< 0.0001	37
GB	55	75	(e)	< 0.0001	< 0.0001	10
GB	Sump	50	> 60	< 0.0001	< 0.0001	53
GB	84	50	(e)	< 0.0001	< 0.0001	(d)
VX	Sump	100	> 60	< 0.0001	< 0.0001	18
VX[c]	7	100	> 60	< 0.0001	< 0.0001	14
VX	17	100	(e)	< 0.0001	< 0.0001	10
VX	Sump	75	> 60	< 0.0001	< 0.0001	23
VX	22	75	(e)	< 0.0001	< 0.0001	10
VX	Sump	50	> 60	< 0.0001	< 0.0001	37
VX	34	50	(e)	< 0.0001	< 0.0001	10

(a) Carbon capacity = 0.05 lb agent/lb carbon, gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the ECV area = 1 second.

(b) Sump area = 4 square feet.

(c) Worst-case fire size/combustion efficiency combination.

(d) The fire burns to completion within 10 minutes.

(e) The fire does not release agent from the ECV area.

TABLE 12. SUMMARY OF ECV AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Residence Time of Fire Products in ECV Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Residence Time (sec.)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	11/100	1	4	< 0.0022	0.0208	16
HD	11/100	2	5	0.0014	0.0116	16
HD	11/100	5	9	0.0004	0.0029	16
HD	11/100	10	26	< 0.0001	0.0005	16
HD	11/100	21.1	> 60	< 0.0001	< 0.0001	16
HD [b]	7/100	21.1	45	< 0.0001	0.0001	21
GB	11/100	1	2	0.0118	0.1780	16
GB	11/100	2	3	0.0083	0.1071	16
GB	11/100	5	3	0.0033	0.0313	16
GB	11/100	10	6	0.0010	0.0071	16
GB	11/100	21.1	21	0.0001	0.0007	16
GB [b]	7/100	21.1	19	< 0.0001	0.0016	22
VX	7/100	1	> 60	< 0.0001	< 0.0001	14
VX	7/100	2	> 60	< 0.0001	< 0.0001	14
VX	7/100	5	> 60	< 0.0001	< 0.0001	14
VX	7/100	10	> 60	< 0.0001	< 0.0001	14
VX	7/100	21.1	> 60	< 0.0001	< 0.0001	14
VX [b]	5/100	21.1	> 60	< 0.0001	< 0.0001	18

(a) Carbon capcity = 0.05 lb agent/lb carbon. The filter inlet gas temperature calculated from heat balances. Worst-case fire size/combustion efficiency combination shown for the 1-second residence time.

(b) Same as in (a) except the worst-case fire size/combustion efficiency combination shown for the 21.1-second residence time.

residence time of 21.1 seconds is equivalent to a fire directly beneath the ECV exhaust duct. A worst-case residence time was assumed to be 1-second.

Table 13 gives a summary of agent releases during an ECV fire for variable carbon capacities. The carbon capacity has a significant effect on agent release. However, the amount of agent release was not directly proportional to the carbon capacity, but varied from about a two-fold to a ten-fold reduction in agent release as the carbon capacity was increased four-fold.

Table 14 gives a summary of agent releases during an ECV fire for various gas temperatures at the filter inlet. The lower gas temperature generally caused a reduction in the amount of HD and GB released by about two orders of magnitude.

The worst-case and most-credible-case agent releases for the ECV Area fire scenario are given in Table 15. The most credible case was based on a 21.1-second residence time for the volatilized agent in the ECV, a carbon capacity of 0.05 lb agent/lb carbon (worst case), a filter inlet gas temperature calculated from heat balances (worst case), and the worst-case fire size/combustion efficiency combination. The worst case was as above except for a 1-second residence time. The most credible case is still very conservative for reasons similar to those given in the TOX Area fire section.

3.1.4 Carbon Bed Fire. Two possible scenarios were considered for ignition of the carbon filter beds -- ignition from an entrained spark and spontaneous ignition. In the former scenario, a spark from a fire in the TOX, ECV, BSA or other area is entrained in the exhaust gases entering the filter banks. This would not cause a fire in the carbon bed because the pre-filter and HEPA filter, located upstream of the carbon beds, would stop the spark. These filters are composed of noncombustible fiberglass. The fiberglass would not achieve the melting temperature and allow the spark to pass through during any of the scenarios evaluated.

In the second scenario, the hot gases exhausted from a fire in the TOX, ECV, BSA, or other area or from a failure in the LIC ductwork, allowing exhaust gases from the operating LIC to enter the LIC room would heat the carbon bed. Based on the configuration of a CAMDS-type carbon bank, the

TABLE 13. SUMMARY OF ECV AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Carbon Capacity Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Carbon Capacity (lb agent/ lb carbon)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	11/100	0.2	4	0.0016	0.0091	16
HD	11/100	0.05	4	0.0022	0.0208	16
HD [b]	7/100	0.2	> 60	< 0.0001	< 0.0001	21
HD [b]	7/100	0.05	45	< 0.0001	0.0001	21
GB	11/100	0.2	3	0.0072	0.0438	16
GB	11/100	0.05	2	0.0118	0.1780	16
GB [b]	7/100	0.2	42	< 0.0001	0.0004	22
GB [b]	7/100	0.05	19	< 0.0001	0.0016	22
VX	7/100	0.2	> 60	< 0.0001	< 0.0001	14
VX	7/100	0.05	> 60	< 0.0001	< 0.0001	14
VX [b]	5/100	0.2	> 60	< 0.0001	< 0.0001	16
VX [b]	5/100	0.05	> 60	< 0.0001	< 0.0001	16

(a) Gas temperature at filter inlet calculated from heat balances. The residence time of the fire products in the ECV area = 1 second. Worst-case fire size/combustion efficiency combinations shown.

(b) Same as in (a) except the residence time of the fire production in the ECV area = 21.1 seconds.

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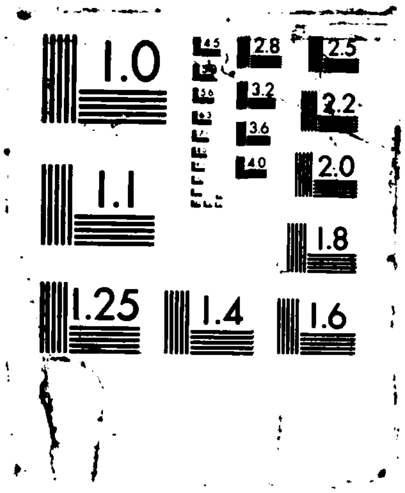
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2.8
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3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

TABLE 14. SUMMARY OF ECV AREA FIRE CALCULATIONS (TON CONTAINER)[a]

Filter Inlet Gas Temperature Varied

Agent	Fire Size/ Combustion Efficiency (sq. ft./%)	Filter Inlet Gas Temperature (F)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	11/100	100	29	< 0.0001	0.0001	16
HD	11/100	115	4	0.0022	0.0208	16
HD [b]	7/100	100	59	< 0.0001	< 0.0001	21
HD [b]	7/100	103	45	< 0.0001	< 0.0001	21
GB	11/100	100	16	< 0.0001	0.0013	16
GB	11/100	117	2	0.0018	0.1780	16
GB [b]	7/100	100	32	< 0.0001	0.0002	22
GB [b]	7/100	105	19	< 0.0001	< 0.0001	22
VX	7/100	100	> 60	< 0.0001	< 0.0001	14
VX	7/100	120	> 60	< 0.0001	< 0.0001	14
VX [b]	5/100	100	> 60	< 0.0001	< 0.0001	16
VX [b]	5/100	117	> 60	< 0.0001	< 0.0001	16

(a) Carbon capcity = 0.05 lb agent/lb carbon. The residence time of the fire products in the ECV area = 1 second. Worst-case fire size/combustion efficiency combinations shown.

(b) Same as in (a) except the residence time of the fire products in the ECV area = 21.1 seconds.

TABLE 15. ECV AREA FIRE WORST CASE/MOST CREDIBLE CASE AGENT RELEASES

WORST CASE (a)

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	11	100	9	< 0.0001	0.0102	16
GB	11	100	7	0.0002	0.0090	16
VX	7	100	> 60	< 0.0001	< 0.0001	14

MOST CREDIBLE CASE(b)

Agent	Fire Size (sq. ft.)	Combustion Efficiency (%)	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After Maximum Fire Duration (lbs.)	Maximum Fire Duration with 99% Probability of Operator Closing Damper (Min.)
HD	11	100	11	< 0.0001	0.0035	16
GB	11	100	8	< 0.0001	0.0149	16
VX	7	100	> 60	< 0.0001	< 0.0001	16

(a) Carbon capacity = 0.05 lb agent/lb carbon, filter inlet gas temperature calculated from heat balances. The residence time of the fire products in the ECV area = 1 second.

(b) Carbon capacity = 0.2 lb agent/lb carbon, filter inlet gas temperature calculated from heat balances. The residence time of the fire products in the ECV area = one second.

minimum ignition temperature of the carbon was estimated to be 230 F (See Appendix A, pages A42 through A44). Raising the temperature of the carbon beds to 230 F or more could cause an ignition if sufficient time is allowed. To determine the sensitivity of temperature/time on carbon ignition, the worst-case filter inlet gas temperatures from the TOX, BSA and ECV Area fires were evaluated. The results, given in Table 16, indicate that spontaneous ignition is unlikely because of the short exposure periods of the carbon filter to elevated temperatures. No other scenarios for potential carbon ignition were identified.

3.1.5 Agent Feed to Nonoperating LIC. This scenario involves the following sequence of events:

(1) Shutdown of LIC burners/combustion air blowers while continued agent feed into the hot, but nonoperating LIC

(2) Closure of the LIC exhaust damper, thereby isolating the LIC from the PAS

(3) Vaporization of agent fed into the LIC as a result of contact with the hot refractory lining. There is a slight pressure buildup in the LIC until agent is vented into the LIC room, probably through the combustion air blower. The exhausted agent is then transported to the filter system via the ventilation.

The amount of agent released versus length of time that agent is fed into the nonoperating LIC was calculated. An agent flow rate into the LIC at a constant rate of 17.5 lb/min for HD and GB and 11.7 lb/min for VX was assumed as a worst case for the calculation. The previous fire scenarios indicated that the filter inlet gas temperature had a significant impact on the amount of agent released. As such, the temperature of the agent exhausted from the LIC was varied by changing the amount of refractory inside the LIC that is used to vaporize and heat the agent. These calculations are given in Appendix A, pages A45 through A49. Results of the calculations, given in Table 17, indicate that an operator has about 33 minutes to stop the agent feed into the nonoperating LIC before the agent release exceeds 0.001 lb.

TABLE 16. TIME REQUIRED FOR SPONTANEOUS IGNITION OF CARBON DUE TO HEATING

Scenario	Agent	Maximum T at Filters, °F	Time to Ignition of Activated Carbon	Fire Duration in Scenario, min.
TOX Fire[a]	HD	154	(b)	76 min
TOX Fire	GB	151	(b)	77 min
TOX Fire	VX	148	(b)	187 min
BSA Fire[a]	HD	305	80 min	8 min
BSA Fire	GB	296	85 min	6 min
BSA Fire	VX	287	100 min	17 min
ECV Fire[a]	HD	167	(b)	14 min
ECV Fire	GB	164	(b)	12 min
ECV Fire	VX	162	(b)	29 min
LIC[c]	All	230	>9 hrs	--

(a) All worst-case values given here

(b) Below minimum temperature required for ignition.

(c) LIC/AB exhausts into LIC area.

TABLE 17. AGENT RELEASE FROM CARBON FILTERS WHILE CONTINUED AGENT FEED INTO NON-OPERATING LIC

Agent	Fraction of LIC Refractory that Heats Agent	Time to Release >0.001 lb Agent (Min.)	Agent Released After 5 Minutes (lbs.)	Agent Released After 20 Minutes (lbs.)
HD	1.0[(a)]	33	< 0.0001	< 0.0001
HD	0.1	(b)	< 0.0001	< 0.0001
GB	1.0	33	< 0.0001	< 0.0001
GB	0.1	(b)	< 0.0001	< 0.0001
VX	1.0	> 60	< 0.0001	< 0.0001
VX	0.1	(b)	< 0.0001	< 0.0001

(a) 1.0 implies that the entire inner layer of high conductivity refractory (4-1/2-inch thick) within the volatilization chamber (52 inches ID by 7-ft. ht.) is available to volatilize agent fed into the LIC.

(b) The refractory cools to below the boiling point before <0.001 lb. is released.

3.1.6 Carbon Filter Desorption. A telephone conversation with Dr. Gerry Wood of the Air Purification Branch at the Chemical Research Development and Engineering Center revealed a general lack of agent desorption data. The desorption process cannot yet be modeled by empirical correlations. However, in qualitative terms, desorption may be insignificant. A report was cited (Reference 1) in which no GB or GD was desorbed after purging a carbon filter for 30 days at ambient temperature.

3.1.7 PAS Agent Scrubbing. The potential for agent removal in the PAS quencher was evaluated. The LIC PAS was used as the basis for the calculations. The calculations are given in Appendix A, pages A50 through A56.

The equations used to estimate agent scrubbing efficiency in the quencher indicated a strong dependence on the droplet size emitted from the quencher spray nozzle. Based on designed flow rates, the nozzles in the quencher should result in a median particle diameter of 1000 microns or less. A diameter of 4000 microns (worst case) and 100 microns (optimistic case) were also evaluated. The effect of gas residence time in the quencher was also evaluated ranging from 2.0 seconds (worst case) to 4.0 seconds (optimistic) as well as the 2.9 second designed residence time.

The results of the calculations are summarized in Table 18. The worst case agent removal efficiency (4000 micron particle size, 2.0 second residence time) was about 50 percent while the most optimistic (100 micron particle size, 4.0 second residence time) was over 99.999 percent. The most credible removal efficiency (1000 microns particle size, 2.9 second residence time) was 68.7 percent.

3.1.8 MPF/Full TC. The MPF accident that was evaluated involves inadvertent processing of a full TC in the MPF. It was assumed that the MPF burners would remain in operation after the TC was placed in the MPF (i.e., plant personnel were unaware that a full TC was placed in the MPF). Several scenarios were evaluated for this accident. Scenario 3 is considered to be the worst case.

In scenario 1, the agent volatilizes from the TC through punched holes at a rate dependent on the MPF burners heat duty. Sufficient area is

TABLE 18. AGENT REMOVAL IN LIC QUENCHER

Liquid Particle Size (Microns)	Residence Time of Gas in Quencher (Sec.)	Removal Efficiency (percent)
4000	2.0	49.7
4000	2.9[(a)]	63.1
4000	4.0	74.7
1000[(b)]	2.0	54.2
1000	2.9[(a)]	68.7
1000	4.0	80.5
100	2.0	98.7
100	2.9[(a)]	99.94
100	4.0	> 99.999

(a) Designed gas residence time.

(b) Typical median particle size from spray nozzle operating at flow rates specified on design drawings.

available in the punched holes so as to prevent over-pressurization of the TCs. Assumptions used in scenario 1 calculations include:

- A single TC placed in the MPF inadvertently
- Agent burns in the TC but container does not rupture
- Combustion-quench air at 3690 lb/hr in MPF
- Agent is at 120 F when placed in the MPF
- MPF operates at 1600 F
- Thermal input to TC is 1,745,953 Btu/hr (Radiation and Convection).

The calculations are given in Appendix A, pages A58 through A63. The agent flow rates from the MPF to the afterburner resulting from scenario 1 are shown in Table 19. The "agent not combusted", shown in Table 19, represents the amount of agent in lb/min not combusted in the MPF under stoichiometric conditions. These values are reasonable considering the fact that the MPF was designed to burn only residual agent on various metal parts and one TC. The agent not combusted in the MPF will flow into the after burner via the MPF exhaust flow and will be thermally decomposed there if the afterburner continues to function, normally with a 2-second residence time for MPF exhaust. As such, no significant agent release to the environment would result during this scenario. Also, as described in the calculations (Appendix A), an agent vapor/air explosion should not be possible due to the limited amount of oxygen available in the MPF.

In scenario 2, the TC would rupture when heated in the MPF due to over-pressurization. The contents of the container would be ejected to the floor of the MPF. All of the agent is not vaporized instantly but, rather, the vaporization rate is dependent on the rate of heat transfer by conduction from the refractory to the agent. Assumptions used in scenario 2 calculations are as follows:

- The agent does not vaporize instantly and it is concentrated on the floor area
- Heat transfer to agent is primarily by conduction through the floor refractory

TABLE 19. TIMES TO VAPORIZE AGENT FROM ONE TON CONTAINER PLACED IN MPF

Agent	Time (min)	Mass Liq (lb)	Mass Vapor (lb)	Vapor Flow (cfm)	Mass of Agent Comb (lb/min)	Mass of Agent not Combusted (lb/min) to Afterburner
HD						
Boil (411 F)	6	1700	0	0	0	0
Sat Vap	15.8	0	1700	968	8.64	99.0
GB						
Boil (316 F)	4.2	1600	0	0	0	0
Sat Vap	12.3	0	1600	1353	7.0	124
VX						
Boil (568 F)	9.4	1500	0	0	0	0
Sat Vap	16.6	0	1500	486	4.0	86.4

- 4.5-in of refractory with high thermal conductivity contributes to heat flux into the liquid
- Agent spills at the boiling point
- Thermal conductivity of the 4.5-in refractory slab is 2.6 Btu/hr-ft-F
- Average slab temperature is 1600 F.

The calculations are given in Appendix A, pages A67 through A77. The agent flow rates from the MPF to the afterburner, summarized in Table 20, indicate that no significant agent release to the environment would occur during this scenario. These flows should be easily combusted in the afterburner since the residence time will be higher than normal without full MPF combustion exhaust. Since the flow capacity for the 24-in-diameter duct is approximately 2500 scfm at the nominal 2 iwg pressure differential between the MPF and afterburner, there will be no pressure rise in the MPF at these conditions.

In scenario 3, the TC ruptures and the entire contents are instantly vaporized. The agent flow rates from the MPF to the afterburner, the afterburner destruction efficiencies (the afterburner was assumed to flame out due to the large spike of agent vapor) and the amounts of agent released to the environment are given in Table 21. The calculations are given in Appendix A, pages A76 through A90. This scenario assumes, as a worst case, that the entire agent is vented through the afterburner. However, because of the over-pressure resulting from the vaporization of the agent, the MPF fume containment would be compromised, thereby expelling agent into the MPF area. Table 22 indicates that over-pressures that would likely cause MDB structural failure can occur if as little as one-fourth of the contents of a TC were expelled to the MPF room in this manner. Because two of the MPF walls are located adjacent to the outside, essentially all of the agent involved could be released to the environment. Any combination of variables could result in a significant agent release to the environment due to the large over-pressures. Although not quantitatively estimated, scenario 3 could result in the essentially instantaneous release of hundreds of pounds of agent to the environment.

TABLE 20. AGENT VAPORIZATION RESULTING FROM AGENT SPILLS ON HOT MPF FLOOR

Agent	Mass Agent Vapor Released (lbm)	Volume Agent Vapor (cu ft)	Time (min)	Ventilation Rate Required (cfm)
HD	1700	14070	16	879
	850	7517	8.2	916
	425	3896	4.1	950
VX	1500	7568	9.7	780
	750	3996	4.8	832
	375	2058	2.4	858
GB	1600	14952	14.2	1053
	800	8008	7.1	1128
	400	4156	3.5	1187

Table 21. Instantaneous Vaporization of Agent in MPF

Scenario No. 3. Analysis of Agent Breakthrough to AFB
Assumptions:
Instantaneous Agent Volitization in MPF
No Agent Pooling
Entire Refractory Volume Contributes to Vaporization (258 cu
Average Refractory Temperature 740 F

Parameters	HD	GB	VX
Ta (F)	707	708	717
Mass Agent (lbm) Worst Case	1700	1600	1500
MW (lb/mole)	159	140.1	267.4
R (ft-lbf/lbmole-R)	1545	1545	1545
Volume (cu ft)	768	768	768
Pressure Rise (psia)	174.3120	186.3500	92.23825
Density @Ta (lb/cu ft)	0.171656	0.149731	0.285643
Volume Req Vent (cfm)	9175.576	9809.240	4855.310
Vent Flow Inst Flash(cfm)	5044545.	5424744.	2452386.
CF Pressure	100.4037	107.3376	53.12923
Flow to MPH Exhaust (cfm)	84962.02	93113.15	47406.10
Actual Flow (acfm)	204168.4	223872.5	114514.1
Time to Purge Agent (sec)	2.696472	2.628970	2.543952
Mass of Agent to AFB (lbm)	1575.047	1468.750	1386.886

Calculation of AFB Breakthrough for AFB Flame Out

AFB Temp	Ta (F)	
Volume AFB in cu ft		522

	HD	GB	VX
Residence Time (t) sec	0.153402	0.139901	0.273503
Mass Breakthrough in AFB (lbm)	611.2651	1079.514	1211.773
Destruction Efficiency (%)	0.611906	0.265011	0.126263

Calculation for AFB Breakthrough AFB Operating @ 1800 F

AFB Temp (F)	1800
Volume AFB in cu ft	522
MPF Exhaust @1600 F ACFM	12630
AFB Exhaust @1800 F ACFM	15670

	HD	GB	VX
Actual Flow to MPF (acfm)	205945.4	225649.5	116291.1
Mass of Agent To AFB (lbm)	1575.047	1468.750	1386.886
Residence Time (sec)	0.152079	0.138799	0.269323
Mass Breakthrough to AFB (lbm)	0	0	0
Destruction Efficiencey (%)	1	1	1

Table 22. MPF Area Overpressure Due to Expulsion of Agent Vapor from the MPF Furnace

Agent	Total Weight (lbs)	MPF Exit Temp. (F)	Agent Gas Volume (cu ft)	MPF Area Temp. (F)	Gas Volume @ ambient P (cu ft)	Vent Rate for No P rise (cfm)	MPF Area P Rise (psig)
HD	1700	1331	13969	639	72754	4,810,075	18.04
HD	850	1454	7464	460	57283	2,953,613	11.07
HD	425	1524	3869	286	45038	1,484,152	5.57
GB	1600	1362	15187	675	75702	5,163,885	19.36
GB	800	1470	8044	484	59055	3,166,191	11.87
GB	400	1532	4151	302	46094	1,610,899	6.04
VX	1500	1335	7349	645	69069	4,367,917	16.38
VX	750	1455	3920	464	55844	2,780,890	10.43
VX	375	1525	2032	290	44536	1,423,940	5.34

3.2 Summary/Conclusions

Sensitivity analyses were performed for several accident scenarios involving relatively large quantities (i.e. over 100 pounds) of agent. A summary of agent releases for the accident scenarios evaluated are given in Table 23. Other conclusions are as follows:

- Insufficient information is available to quantify desorption of agent from carbon filters.
- Between 50 (worst-case) and 99.999 (most-credible-case) percent removal efficiencies of agent are anticipated in the PAS quencher.

3.3 References

1) Morrison, R. W.; Rogers, C. L.; Grue, R. C.; and Hiob, G. D.; "Effect of Relative Humidity on the Performance of ASC Carbon in the Removal of Chemical Agents", CRDC-TR-86012, February, 1986.

TABLE 23. SUMMARY OF AGENT RELEASES FROM ACCIDENT SCENARIOS EVALUATED IN THE SENSITIVITY ANALYSES

Scenario	Agent	Worst-Case Agent Release (lbs)	Most-Credible-Case Agent Release (lbs)
TOX Area Fire	HD	0.2814	0.0050
	GB	6.4324	0.1613
	VX	< 0.0001	< 0.0001
BSA Area Fire(b)	HD	75.2408	6.8254
	GB	168.7586	28.8833
	VX	0.1391	< 0.0001
BSA Area Fire(c)	HD	0.0004	–
	GB	0.3593	–
	VX	< 0.0001	–
ECV Area Fire	HD	0.0288	0.0001
	GB	0.1788	0.0016
	VX	< 0.0001	< 0.0001
Carbon Filter Fire	HD	(d)	(d)
	GB	(d)	(d)
	VX	(d)	(d)
Agent Feed to non-operating LIC	HD	< 0.0001	< 0.0001
	GB	< 0.0001	< 0.0001
	VX	< 0.0001	< 0.0001
Feed Full TC into MPF (Scenarios 1 and 2)	HD	< 0.0001	–
	GB	< 0.0001	–
	VX	< 0.0001	–
Feed Full TC into MPF (Scenario 3)	HD	> 100	–
	GB	> 100	–
	VX	> 100	–

(a) Agent releases for the fire scenarios are for the maximum fire duration.
(b) The agent releases given here are for a leaking TC.
(c) The agent releases given here are for a ruptured TC and assumes agent release from a sump fire.
(d) Ignition of the carbon is not anticipated in any of the evaluated scenarios.

APPENDIX C
STRUCTURAL ANALYSIS

C.1. STRUCTURAL ANALYSIS

This appendix summarizes the structural analysis methodology used to determine failure thresholds and probabilities for munitions and structures. Supporting calculation for the results used in this study can be found in Ref. C-1.

C.1.1. PUNCTURE

This section addresses two types of munition puncture: (1) puncture due to dropping a munition; and (2) forklift puncture.

C.1.1.1. Puncture Due to Drop

The probability P_F of a munition puncturing on impact with a probe depends on the type of munition, the number of probes to which a dropped munition is exposed, and the geometry of the probe. This probability is computed from the following:

$$P_F = P_B \times PLL \times PD \times A_s \quad ,$$

where P_B = probe density (number of probes per square foot of surface area),

PLL = an admissible probability value for probe length to diameter ratio,

PD = an admissible probability value for probe diameter,

A_s = the area of the munition in square feet which is subject to penetration by the probe.

The number of probes per square foot of surface area (P_B) is based on engineering judgment. It is assumed that the igloo is clean and that objects that could be potential probes are not likely to be left in the igloo. Therefore, one probe per igloo (i.e., one probe per 2160 ft^2) was assumed for igloo storage. For all other storage areas, a probe density of one per 1000 ft^2 was assumed. In the general working area, loading docks, etc., it is assumed that the potential for probes will be much more likely than in an igloo. Probes such as posts, tools, rocks, or chunks of steel are possible; therefore, one probe per 100 ft^2 is assumed for the general working area. In the UPA during an earthquake, it is assumed that the earthquake could generate additional probes by causing objects to fall onto the floor; therefore, one probe per 50 ft^2 is assumed for the UPA during an earthquake.

The PLL term in the above expression represents the probability that the probe has a length-to-diameter ratio (L/D) which is less than that which would cause buckling failure of the probe without penetration of the dropped munition but greater than that corresponding to a probe length which is insufficient to penetrate the munition. Probe dimensions (diameter and L/D) were treated statistically and the minimum probe length for penetration was calculated for each munition.

The PD term in the above expression represents the probability that the diameter of the probe is less than or equal to the maximum that could penetrate the munition but greater than a minimum diameter corresponding to the compressive strength of the probe. The maximum diameter of the probes which could penetrate through the munition wall is determined from

$$D_u = \frac{(W \times H)^{0.667}}{672\ t} ,$$

where D_u = maximum probe diameter (in.),

W = weight of munition/pallet (lb),

H = drop height (ft),

t = munition thickness (in.).

These expressions are taken from Ref. C-2.

The munition area vulnerable to probe penetration (A_s) was determined assuming a maximum probe length of 2 in. This term was calculated for each munition/pallet configuration of interest and reflects the number of munitions involved in each handling operation. Thus, if more than one munition were being handled, the vulnerable area of each munition was multiplied by the actual number of munitions involved in the handling event.

C.1.1.2. <u>Forklift Tine Puncture</u>

For forklift tine puncture, the munitions are at rest and the probe (the forklift tine) is the moving object. This makes calculating the munition vulnerability simpler since the mass of the moving object (the forklift) and the shape of the probe (the tine) are the same for all munitions. The only variable is the munition thickness. Since the puncture energy is proportional to the thickness of the munition, the relative puncture resistance of the munitions is simply the ratio of the thicknesses.

The probability P of a forklift tine puncture of the munitions was assumed to be governed by

$$P = P_1 * P_2 * N \quad ,$$

where P_1 = the probability that a munition is struck by a forklift tine per pallet operation,

P_2 = the probability that the munition is punctured given that the forklift tine strikes the munition,

N = number of handling operations.

The critical puncture velocity V_c (in ft/s) was determined from

$$V_c = \frac{64}{W}(672\ Dt)^{3/2} \quad ,$$

where W = weight of the forklift (lb),

D = equivalent diameter of the forklift tine (in.),

t = munition wall thickness (in.).

C.1.2. WIND-GENERATED MISSILES

The probability of a wind-generated missile rupturing a munition is the product of two probabilities: (1) the probability of having a wind of sufficient velocity to generate a missile that can rupture a munition and (2) the probability that the missile hits the munitions in an orientation that will rupture the munition.

C.1.2.1. Required Wind Velocity

The wind velocity required to generate a missile that can penetrate a munition is computed as follows:

1. The missile velocity required to penetrate the munition is computed using the equation (Ref. C-2):

$$V_m = 0.682 \quad \frac{64}{W} \; (672 \; Dt)^{3/2} \quad ,$$

where V_m = the penetration velocity (mph),
W = the weight of the missile (lb),
D = the equivalent missile diameter (in.),
t = the wall thickness of the munition (in.).

Each munition was evaluated for two critical missiles: a 10-ft section of 3-in. pipe and a 13.5-in. diameter utility pole. In addition to penetration, the utility pole was evaluated to determine the velocity required to crush the munition.

2. The missile velocity required to penetrate the storage structure was also computed using the following equation (Ref. C-2).

For concrete structures:

$$V_s = 1000 \left(\frac{f_c\ T\ D^{1.8}}{427\ W} \right)^{0.75} ,$$

where T = thickness of concrete element to be just perforated (in.),

W = weight of missile (lb),

D = diameter of missile (in.),

V_s = striking velocity of missile (fps),

f_c = compressive strength of concrete (psi).

For steel structures:

$$V_s = 0.682 \left(\frac{64}{W} \right) (672\ DT)^{3/2} .$$

3. The missile velocity required to penetrate both the munition and structure is computed using the following equation which is based on summing the energies required to penetrate the munition and structure separately:

$$V = \sqrt{V_m^2 + V_s^2} ,$$

where V_m = velocity required to penetrate the munition,

V_s = velocity required to penetrate the structure.

4. The probability of the required wind occurring was based on functional data for each site.

C.1.2.2. Probability of Hitting and Rupturing the Munition

Given a sufficient wind, the probability that a missile hits and ruptures a munition was computed from:

$$P = P_d \, P_o \, D \, A \quad ,$$

where P_d = probability that the direction of missile travel is nearly perpendicular to the target,

P_o = probability that the missile is oriented to penetrate (i.e., not tumbling or going sideways),

D = number of missiles per unit area,

A = area of target.

Values for P_d, P_o, and D are difficult to evaluate and are not available from the literature. Consequently, the values used for the analysis were computed based on engineering judgment. These values were selected to give a "best estimate" of the overall probability. The following is a discussion of these assumptions.

The missile velocity must be nearly perpendicular to the wall of a structure or munition in order for the missile to penetrate. The further the missile strikes from an angle which is perpendicular, the less likely that the missile will penetrate. As the angle deviates from the perpendicular, the effective thickness of munition increases proportionally to the reciprocal of the cosine of the angle (where the angle is measured from the perpendicular); thus, a higher missile velocity (which has a lower probability of occurring) is required for penetration. In addition, the missile is more likely to ricochet at higher angles. Based on engineering judgment, it is estimated that if the

missile velocity is more than 30 deg off from perpendicular, the missile will not penetrate. This yields a value of 0.17 for P_d.

The missile velocity must be aligned along the missile axis in order for the missile to penetrate. In other words, the missile must move like an arrow rather than tumbling or going sideways. Of the two missiles analyzed, it was found that it is more important that the pipe be aligned properly than the utility pole because of the larger impact area of the utility pole. For this reason, it was assumed that the velocity must be aligned within 5 deg of the axis of the pipe and within 10 deg of the axis of the utility pole. These assumptions resulted in values for P_o of 0.004 for the pipe and 0.015 for the utility pole.

The path of the tornado is generally from 1/8 to 3/4 of a mile wide (Ref. C-3). For this analysis, it was assumed that the tornado is 1/2 mile wide and that it carries one utility pole and 10 iron pipes. It was further assumed that the pipes are evenly distributed to a height of 50 ft and the utility pole at a height of 20 ft (Ref. C-4 indicates the maximum heights for pipes is 100 ft and for utility poles is 50 ft which indicates that our assumption is conservative). Therefore, the number of missiles per square foot of wind (D) is 7.6×10^{-5} for pipes and 1.9×10^{-5} for utility poles.

The target area is different for each scenario and depends on the number of munitions involved and the storage configuration (see Ref. C-1).

The product of P_d, P_o, and D is approximately 5.0×10^{-8} for both the pipes and utility pole.

C.1.3. EARTHQUAKE AND WIND FAILURE OF UBC DESIGNED STRUCTURES

C.1.3.1. Strength Factor of Safety

The Uniform Building Code (UBC) ensures that structures are designed with a factor of safety. This factor of safety varies depending on the type of structure, materials used and components selected. For earthquake and wind loads, this factor of safety ranges from 1.3 to 1.6 for concrete structures designed to ultimate design strength principals and from 2.6 to 3.0 for concrete and steel structures designed to working stress methods. For the risk analyses in this report, it is assumed that the factor of safety will be 1.3 for concrete structures (since the CONUS structures are being designed to ultimate strength) and 2.6 for the steel structures.

C.1.3.2. Wind Loads

For UBC-designed concrete structures such as the MDB, wind does not govern the design of the main structural components. The MDB is a rigid concrete moment resisting framed and shear wall structure and will fail under seismic conditions only. For the steel structures such as the bulk agent warehouses, the wind governs the design in most cases. Wind loads will fail the walls of the structure before the structure will collapse. Since the stresses in a structure due to winds are proportional to the square of the wind velocity, a wind velocity which is 1.6 (square root of the 2.6 factor of safety on strength) times greater than the design wind load can be expected to fail the walls of the steel structure.

C.1.3.3. Earthquake Loads

The Applied Technology Council (ATC), which is associated with the SEAOC, presents a set of curves that can be used to estimate the probability of an earthquake, which exceeds a specific g-level, occurring

anywhere in the U.S. (Ref. C-5). These curves are shown in Fig. C-1. Each curve represents a seismic map area which is similar to the seismic zones used by the UBC. The ATC divided the country into seven seismic map areas (1-7). The UBC uses five seismic zones (0-4). Reference C-5 contains maps showing the seismic map areas. These maps color code the seismic map areas, and, consequently, have not been reproduced for this report since a black and white reproduction would not be helpful. The maps show that APG, ANAD, LBAD, PBA, UMDA, and PUDA are in seismic map area 2; NAAP is in seismic map area 3; and TEAD is in seismic map area 5.

Figure C-1 presents the seismic risk curves for seismic map areas 2, 3, 5, and 7.

The earthquake g-level that will fail a structure depends on four principal factors: (1) the design g-level, (2) the strength factor of safety, (3) the dynamic amplification in the structure, and (4) the ductility of the structure. The dynamic amplification factor reduces the factor of safety, and the ductility increases the factor of safety. The dynamic amplification factor has been conservatively estimated at 2.3 based on a referenced analysis (Ref. C-6). Ductility factors are estimated to be in the range of 2.5 to 3.5 for concrete structures with shear walls and from 3.5 to 5.0 for steel structures. For this analysis, 2.5 was used for concrete walls and 3.5 was used for steel-walled structures. Based on these factors, a UBC structure with concrete walls was assumed to fail at an earthquake g-level that is approximately 1.4 times the design g-level, and a UBC structure with steel walls was assumed to fail at a g-level that is approximately 4.0 times greater than the design g-level.

For UBC designed structures with concrete walls in Seismic Zone 3 (design g-level of 0.14), the expected failure g-level is 0.4 g. Due to the uncertainty of the analysis, there is a probability that the structure will survive larger earthquakes or will fail during smaller

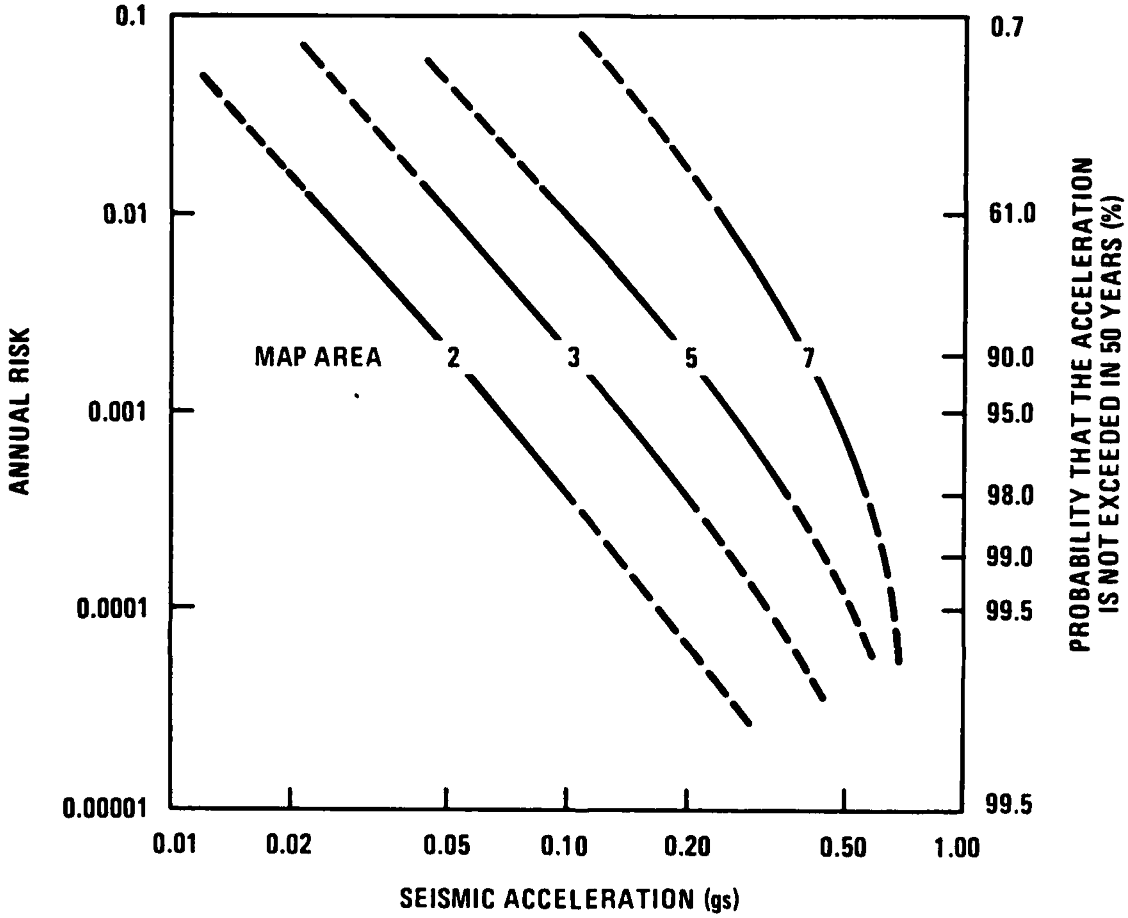

Fig. C-1. Annual risk exceeding various seismic accelerations

earthquakes. Consequently, the following probabilities of failure have been assumed:

1. A 0.3-g earthquake has a 0.1 probability of producing failure.
2. A 0.4-g earthquake has a 0.5 probability of producing failure.
3. A 0.5-g earthquake has a 0.9 probability of producing failure.
4. A 0.6-g earthquake has a 1.0 probability of producing failure.

The failure g-levels for Seismic Zone 2 are half of the g-levels for Seismic Zone 3 since the design g-level for Seismic Zone 2 (0.07 g) is half the design g-level for Seismic Zone 3 (0.14 g).

For UBC designed structures with steel walls in Seismic Zone 2 (the warehouses at NAAP and UMDA), the following probabilities of failure have been assumed:

1. A 0.2-g earthquake has a 0.1 probability of producing failure.
2. A 0.3-g earthquake has a 0.5 probability of producing failure.
3. A 0.4-g earthquake has a 0.9 probability of producing failure.
4. A 0.5-g earthquake has a 1.0 probability of producing failure.

C.1.4. EARTHQUAKE FAILURE OF NRC-DESIGNED STRUCTURES

The TOX cubicle, tank, and piping system will be designed to Nuclear Regulatory Commission (NRC) standards for nuclear power plants. In summary, this will involve the following:

1. Seismic experts will determine the "maximum credible earthquake" that can occur at TEAD based on the seismic history of the area and the proximity of earthquake faults. This "maximum credible earthquake" will be selected as the safe shutdown earthquake (SSE) to be used as the design earthquake for the TOX at all eight sites.

2. The TOX will be analyzed for the SSE using finite-element time-history computer programs.

3. The TOX will be constructed to NRC standards.

Since the SSE for TEAD has not been selected, an SSE g-level had to be assumed for this risk analysis. The SSE selected by the seismic experts for TEAD is expected to be between 0.3 and 0.5 g. For this risk analysis, it was conservatively assumed that the TOX will be designed for a 0.3-g SSE.

Since the TOX will be designed for no failures in the event of a SSE, an earthquake larger than the SSE will be required to produce a failure. Since the NRC seismic design requirements are quite different from the UBC seismic requirements, the methodology used to determine failure g-levels for the UBC structures does not apply to NRC-designed structures. Based on GA's experience in seismic design of nuclear power plants, it was estimated that an earthquake which is twice the SSE will have a 0.5 probability of either rupturing the TOX tank/piping system or breaching the TOX wall. There is a possibility that the TOX will survive larger earthquakes or that a smaller earthquake will cause a

failure. Consequently, the following probabilities are selected for the rupture of the TOX storage tank and for the breaching of the TOX walls:

1. A 0.5-g earthquake has a 0.1 probability of producing failure.
2. A 0.6-g earthquake has a 0.5 probability of producing failure.
3. A 0.7-g earthquake has a 0.9 probability of producing failure.
4. A 0.8-g earthquake has a 1.0 probability of producing failure.

C.1.5. METEORITES

The probability of a meteorite penetrating a munition can be estimated from:

$$P = F\,(f_i + f_s)\,A\,S \quad ,$$

where F = frequency of meteorite strikes per square foot of area,

f_i = fraction of the striking meteorites which are iron meteorites and can penetrate the target,

f_s = fraction of the striking meteorites which are stone meteorites and can penetrate the target,

A = area of target,

S = fraction of the target area which must be impacted to rupture a munition or bulk agent container (spacing factor).

The frequency of meteorite strikes for meteorites 1.0 lb or greater is $0.4 \times 10^{-13}/ft^2$ (Ref. C-7). For small meteorites (a ton or less), stone meteorites are approximately 10 times more common than iron meteorites (Ref. C-8). However, iron meteorites are more dense and tend to have higher impact velocities, and consequently, represent a significant portion of the total meteorites that can rupture munitions. The size distribution of both iron and stone meteorites striking the earth surface was estimated from the data presented in Refs. C-7 and C-8.

The size of the meteorite required to penetrate a munition or munition and structure was computed using the equations presented in Ref. C-2. The impact velocity was computed based on the data presented

in Ref. C-8, which gives impact velocities for a series of large meteorites. These data were plotted and extrapolated to estimate the velocities for the smaller meteorites. For the smallest stone meteorites, the extrapolation yields impact velocities which were less than their terminal velocities. In these cases the terminal velocities are used.

C.1.6. AIRCRAFT CRASH

The probabilities used in the analysis of crashes involving aircraft takeoffs and landings were obtained by modifying Table C-1, which was taken from Ref. C-9. The following modifications were made to this table:

1. U.S. air carrier (commercial) crash probabilities between 5 and 8 miles from the end of the runway were increased from 0.0 to 0.14×10^{-8} which is equal to the probability for crashes between 8 and 9 miles from the end of the runway.

2. The probabilities for USN/USMC were averaged with the probabilities for USAF to obtain probabilities for military aircraft in general.

3. The probabilities for crashes of military aircraft at distances which are 5 to 10 miles from the runway were assumed to be the same as for U.S. commercial air carriers.

4. The general aviation probabilities for crashes which are 5 to 10 miles from the end of the runway are assumed to be five times greater than U.S. air carrier probabilities.

5. Helicopter crash probabilities were assumed to be twice the probabilities for general aviation.

Tables C-2 through C-17 summarize the input data that were used to calculate the annual probabilities of both small and large aircraft crashes at each of the eight sites. The effective areas of the crash sites are summarized in Table C-18.

TABLE C-1
AIRCRAFT CRASH PROBABILITIES NEAR AIRPORTS[a]

Distance From End of Runway (miles)	Probability (x 10^8 of a Fatal Crash per Square Mile per Aircarft Movement[a]			
	U.S. Air Carrier	General Aviation	USN/USMC	USAF
0-1	16.7	84.0	8.3	5.7
1-2	4.0	15.0	1.1	2.3
2-3	0.96	6.2	0.33	1.1
3-4	0.68	3.8	0.31	0.42
4-5	0.27	1.2	0.20	0.40
5-6	0	NA	NA	NA
6-7	0	NA	NA	NA
7-8	0	NA	NA	NA
9-9	0.14	NA	NA	NA
9-10	0.12	NA	NA	NA

[a]Reference C-9.

TABLE C-2
CRASH OF A LARGE AIRPLANE AT APG

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
NONE											0

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
PHILLIPS AAF	8	1.2e+01	1.4e-09	1.7e-08	1.0e+02	1.4e-09	1.5e-07	5.2e+01	7.0e-09	3.6e-07	5.3e-07
WEIDE AAF	1	0.0e+00	1.7e-07	0.0e+00	0.0e+00	7.0e-08	0.0e+00	0.0e+00	8.4e-07	0.0e+00	0.0e+00
										TOTAL	5.3e-07

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-3
CRASH OF A SMALL AIRPLANE AT APG

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
-	5	1.2e+01	4.0e-10	9.6e-10	2.4e+01	2.0e-09	9.6e-09	1.2e+01	2.0e-09	4.8e-09	1.5e-08

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
PHILLIPS AAF	8	1.2e+01	1.4e-09	1.7e-08	2.4e+01	1.4e-09	3.4e-08	2.4e+01	7.0e-09	1.7e-07	2.2e-07
WEIDE AAF	1	0.0e+00	1.7e-07	0.0e+00	4.0e+02	7.0e-08	2.8e-05	1.3e+03	8.4e-07	1.1e-03	1.1e-03
										TOTAL	1.1e-03

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-4
CRASH OF A LARGE AIRPLANE AT ANAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J14-52	8	1.0e+04	4.0e-10	5.0e-07	5.0e+03	2.0e-09	1.3e-06	5.0e+03	2.0e-09	1.3e-06	3.0e-06
V18	12	4.0e+03	4.0e-10	1.3e-07	2.4e+03	2.0e-09	4.0e-07	4.0e+03	2.0e-09	6.7e-07	1.2e-06
IR69	4	0.0e+00	4.0e-10	0.0e+00	7.3e+03	2.0e-09	3.7e-06	0.0e+00	2.0e-09	0.0e+00	3.7e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	7.9e-06

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-5
CRASH OF A SMALL AIRPLANE AT ANAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J14-52	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
V18	12	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+04	2.0e-09	1.2e-05	1.2e-05
IR69	4	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.2e-05

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-6

CRASH OF A LARGE AIRPLANE AT LBAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J6	8	5.0e+03	4.0e-10	2.5e-07	2.5e+03	2.0e-09	6.3e-07	2.5e+03	2.0e-09	6.3e-07	1.5e-06
J43	12	5.0e+03	4.0e-10	1.7e-07	2.5e+03	2.0e-09	4.2e-07	2.5e+03	2.0e-09	4.2e-07	1.0e-06
BOMBING RUN	4	0.0e+00	4.0e-10	0.0e+00	4.0e+03	2.0e-09	2.0e-06	0.0e+00	2.0e-09	0.0e+00	2.0e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	4.5e-06

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-7
CRASH OF A SMALL AIRPLANE AT LBAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J6	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
J43	12	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
BOMBING RUN	4	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
-	8	4.0e+02	4.0e-10	2.0e-08	2.4e+02	2.0e-09	6.0e-08	4.0e+02	2.0e-09	1.0e-07	1.8e-07

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.8e-07

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-8
CRASH OF A LARGE AIRPLANE AT NAAP

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J73	8	5.0e+03	4.0e-10	2.5e-07	2.5e+03	2.0e-09	6.3e-07	2.5e+03	2.0e-09	6.3e-07	1.5e-06
J80	8	5.0e+03	4.0e-10	2.5e-07	2.5e+03	2.0e-09	6.3e-07	2.5e+03	2.0e-09	6.3e-07	1.5e-06
V171	8	2.0e+03	4.0e-10	1.0e-07	1.2e+03	2.0e-09	3.0e-07	2.0e+03	2.0e-09	5.0e-07	9.0e-07
V434	10	2.0e+03	4.0e-10	8.0e-08	1.2e+03	2.0e-09	2.4e-07	2.0e+03	2.0e-09	4.0e-07	7.2e-07

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
ROWE	8	0.0e+00	1.4e-09	0.0e+00	0.0e+00	1.4e-09	0.0e+00	0.0e+00	7.0e-09	0.0e+00	0.0e+00
										TOTAL	4.6e-06

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-9
CRASH OF A SMALL AIRPLANE AT NAAP

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J73	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
J80	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
V171	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	3.5e+04	2.0e-09	8.7e-06	8.7e-06
V434	10	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	3.5e+04	2.0e-09	7.0e-06	7.0e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
ROWE	8	0.0e+00	1.4e-09	0.0e+00	0.0e+00	1.4e-09	0.0e+00	1.0e+03	7.0e-09	7.0e-06	7.0e-06
										TOTAL	2.3e-05

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-10
CRASH OF A LARGE AIRPLANE AT PBA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J42	8	5.0e+03	4.0e-10	2.5e-07	2.5e+03	2.0e-09	6.3e-07	2.5e+03	2.0e-09	6.3e-07	1.5e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.5e-06

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-11
CRASH OF A SMALL AIRPLANE AT PBA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J42	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
-	8	4.0e+02	4.0e-10	2.0e-08	2.4e+02	2.0e-09	6.0e-08	4.0e+02	2.0e-09	1.0e-07	1.8e-07

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.8e-07

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-12

CRASH OF A LARGE AIRPLANE AT PUDA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J28	8	1.0e+03	4.0e-10	5.0e-08	5.0e+02	2.0e-09	1.3e-07	5.0e+02	2.0e-09	1.3e-07	3.0e-07
J17	10	1.0e+03	4.0e-10	4.0e-08	5.0e+02	2.0e-09	1.0e-07	5.0e+02	2.0e-09	1.0e-07	2.4e-07
V10-244	8	4.0e+02	4.0e-10	2.0e-08	2.4e+02	2.0e-09	6.0e-08	4.0e+02	2.0e-09	1.0e-07	1.8e-07
V19-83	8	4.0e+02	4.0e-10	2.0e-08	2.4e+02	2.0e-09	6.0e-08	4.0e+02	2.0e-09	1.0e-07	1.8e-07
V81	10	4.0e+02	4.0e-10	1.6e-08	2.4e+02	2.0e-09	4.8e-08	4.0e+02	2.0e-09	8.0e-08	1.4e-07
V389	10	4.0e+02	4.0e-10	1.6e-08	2.4e+02	2.0e-09	4.8e-08	4.0e+02	2.0e-09	8.0e-08	1.4e-07

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
PUEBLO MEMORIAL	8	9.1e+03	1.4e-09	1.3e-05	9.1e+03	1.4e-09	1.3e-05	4.6e+03	7.0e-09	3.2e-05	5.8e-05
										TOTAL	5.9e-05

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-13
CRASH OF A SMALL AIRPLANE AT PUDA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J28	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
J17	10	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
V10-244	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+03	2.0e-09	1.7e-06	1.7e-06
V19-83	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+03	2.0e-09	1.7e-06	1.7e-06
V81	10	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+03	2.0e-09	1.4e-06	1.4e-06
V389	10	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+03	2.0e-09	1.4e-06	1.4e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
PUEBLO MEMORIAL	8	0.0e+00	1.4e-09	0.0e+00	0.0e+00	1.4e-09	0.0e+00	1.4e+04	7.0e-09	9.8e-05	9.8e-05
										TOTAL	1.0e-04

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-14

CRASH OF A LARGE AIRPLANE AT TEAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
V257	8	8.0e+02	4.0e-10	4.0e-08	4.8e+02	2.0e-09	1.2e-07	8.0e+02	2.0e-09	2.0e-07	3.6e-07

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	3.6e-07

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-15
CRASH OF A SMALL AIRPLANE AT TEAD

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
V257	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	1.4e+04	2.0e-09	3.5e-06	3.5e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	3.5e-06

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-16
CRASH OF A LARGE AIRPLANE AT UMDA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J54	8	1.0e+04	4.0e-10	5.0e-07	5.0e+03	2.0e-09	1.3e-06	5.0e+03	2.0e-09	1.3e-06	3.0e-06
J20	12	1.0e+04	4.0e-10	3.3e-07	5.0e+03	2.0e-09	8.3e-07	5.0e+03	2.0e-09	8.3e-07	2.0e-06
V4	12	4.0e+03	4.0e-10	1.3e-07	2.4e+03	2.0e-09	4.0e-07	4.0e+03	2.0e-09	6.7e-07	1.2e-06
VR1354	6	0.0e+00	4.0e-10	0.0e+00	2.5e+04	2.0e-09	8.3e-06	0.0e+00	2.0e-09	0.0e+00	8.3e-06

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.5e-05

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-17

CRASH OF A SMALL AIRPLANE AT UMDA

AIRWAYS

ROUTE	ROUTE WIDTH	COMMERCIAL N	COMMERCIAL C1	COMMERCIAL P	MILITARY N	MILITARY C1	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C1	GENERAL AVIATION P	ALL P
J54	8	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
J20	12	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00
V4	12	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	7.0e+04	2.0e-09	1.2e-05	1.2e-05
VR1354	6	0.0e+00	4.0e-10	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00	2.0e-09	0.0e+00	0.0e+00

AIRPORTS

AIRPORT	MILES TO SITE	COMMERCIAL N	COMMERCIAL C2	COMMERCIAL P	MILITARY N	MILITARY C2	MILITARY P	GENERAL AVIATION N	GENERAL AVIATION C2	GENERAL AVIATION P	ALL P
NONE											0.0e+00
										TOTAL	1.2e-05

N = Number of flights per year
C1= Probability of a crash per mile
C2= Probability of a crash per sq. mile
P = Probability of a crash per sq. mile per year

TABLE C-18
EFFECTIVE AREAS OF CRASH SITES[a]

Storage Facility	Large Aircraft Direct Crash	Large Aircraft Adjacent Crash	Small Aircraft Direct Crash
80-ft igloo	7.6E-5	4.8E-5	0.0E+0
60-ft igloo	5.7E-5	3.7E-5	0.0E+0
40-ft igloo	3.8DE-5	2.4E-5	0.0E+0
89-ft magazine	8.2E-5	4.6E-5	0.0E+0
Warehouse at TEAD	2.4E-3	2.4E-3	3.0E-3
Warehouse at UMDA	1.6E-3	1.8E-3	2.1E-3
Warehouse at NAAP	7.9E-4	1.7E-3	1.3E-3
Open storage at APG	4.6E-3	4.9E-3	5.7E-3
Open storage at PBA	1.1E-2	6.6E-3	1.3E-2
Open storage at TEAD	2.2E-2	1.2E-2	2.5E-2
Train (50 cars)	1.1E-2	1.6E-2	5.4E-3
ECR	5.4E-5	--	--
UPA	2.4E-4	--	1.6E-4
TOX	4.1E-5	--	--
Truck	3.6E-4	--	9.0E-5
Outside agent piping at TEAD	1.8E-3	--	5.9E-4

[a]Units of area is square miles.

C.1.7. REFERENCES

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C-3. "Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites," ANSI/ANS-2.3-1983, 1983.

C-4. Coats, D. W., "National Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites," UCRL-53526, Lawrence Livermore National Laboratory, February 1984.

C-5. "Tentative Provisions for the Development of the Seismic Regulations for Buildings," Applied Technology Council, ATC 3-06, NBS SP-510, NSF 78-8, June 1978.

C-6. "Structural Analysis and Design of Nuclear Plant Facilities," American Society of Civil Engineers, Manuals and Reports on Engineering Practice No. 58, 1980.

C-7. Solomon, K. A., K. C. Erdmann, and D. Okrent, "Estimate of the Hazards to a Nuclear Reactor from the Random Impact of Meteorites," Nuclear Technology, Vol. 25, January 1975.

C-8. Blake, V. E., "A Prediction of the Hazards from the Random Impact of Meteorites on the Earth's Surface," Sandia Laboratories SC-RR-86-838, December 1968.

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APPENDIX D
SITE INFORMATION

D.1. SITE INFORMATION

This appendix discusses the location and characteristics of the eight CONUS sites where chemical munitions are stored and provides a brief description of the storage areas. Figure D-1 shows the general location of the eight sites. The site characteristics discussed included recorded earthquake activity and aircraft patterns in the vicinity.

D.1.1. ABERDEEN PROVING GROUND

As shown in Figs. D-2 and D-3, the Aberdeen Proving Ground (APG) is located in Harford County, Maryland near the head of the Chesapeake Bay.

APG is a Test and Evaluation Command (TECOM) installation within U.S. Army Materiel Command (AMC). The main activities/mission of APG include testing and evaluating vehicles, munitions, and other combat hardware. A major tenant activity, the Chemical Research, Development, and Engineering Center (CRDEC), is located at APG.

APG is comprised of two general areas, the Aberdeen Area and Edgewood Area. The Edgewood Area is situated adjacent to the town of Edgewood in the southwestern part of Harford County. There have occurred in the vicinity of the APG site 48 recorded earthquakes of Modified Mercalli Intensity (MMI) levels from I to VII, as summarized in Table D-1.

The chemical storage area at APG is located in the northeast corner of the Edgewood Area. The Chemical Agent Storage Yard (CASY) is an open area encompassing approximately 5 acres and is situated along the Bush

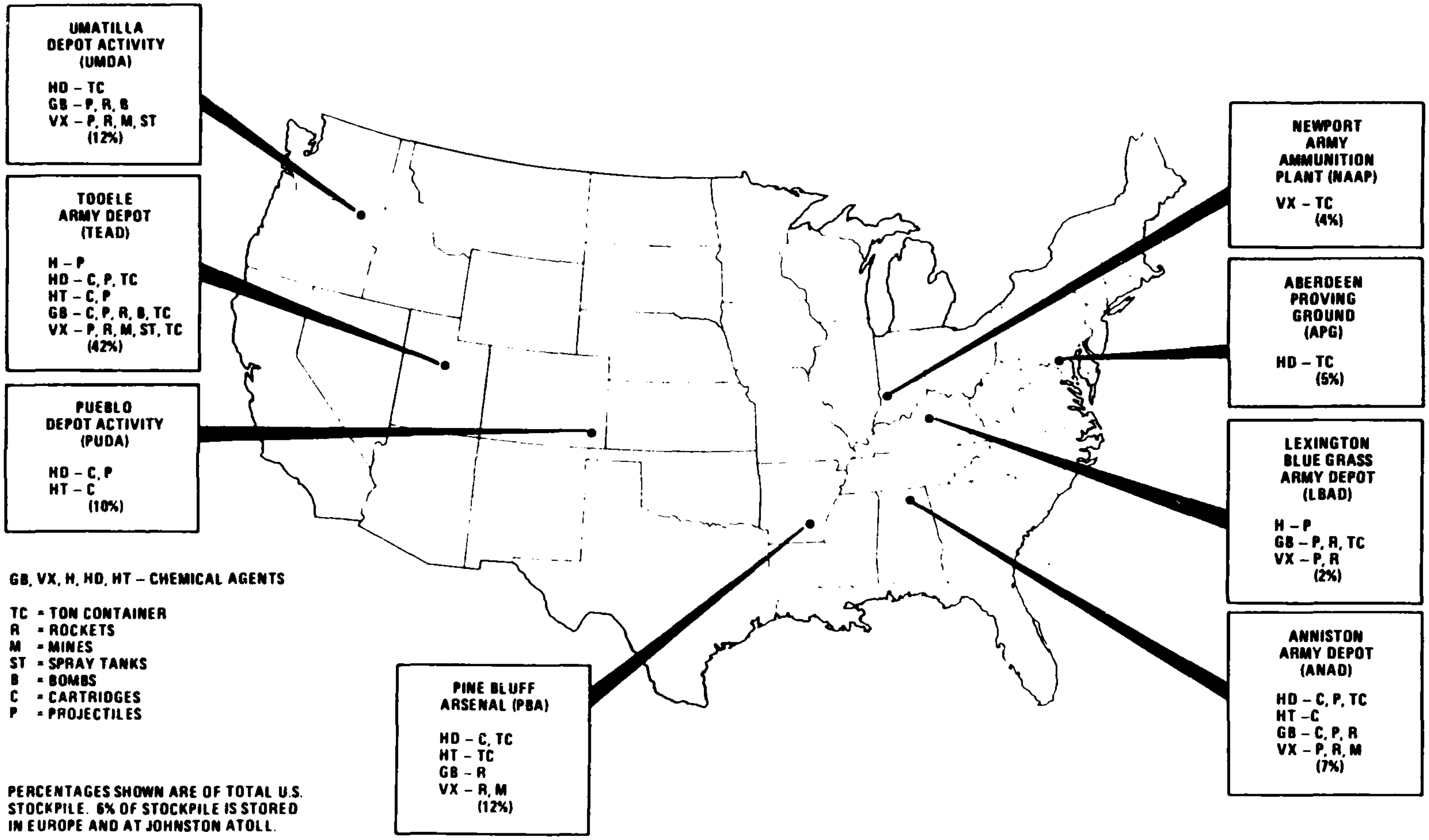

Fig. D-1. Location of chemical agents and munitions in the U.S.

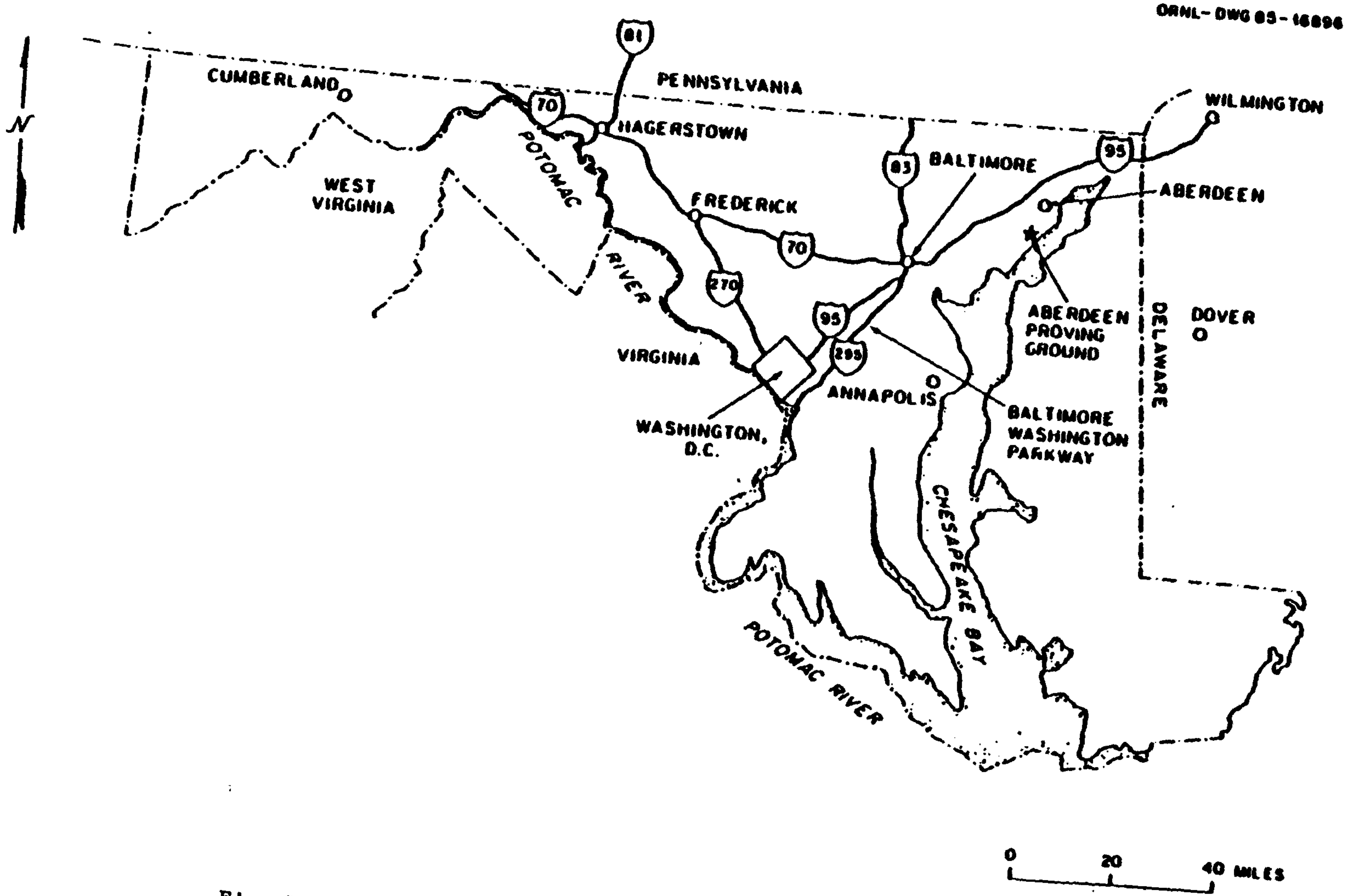

Fig. D-2. Maryland state map showing the location of APG

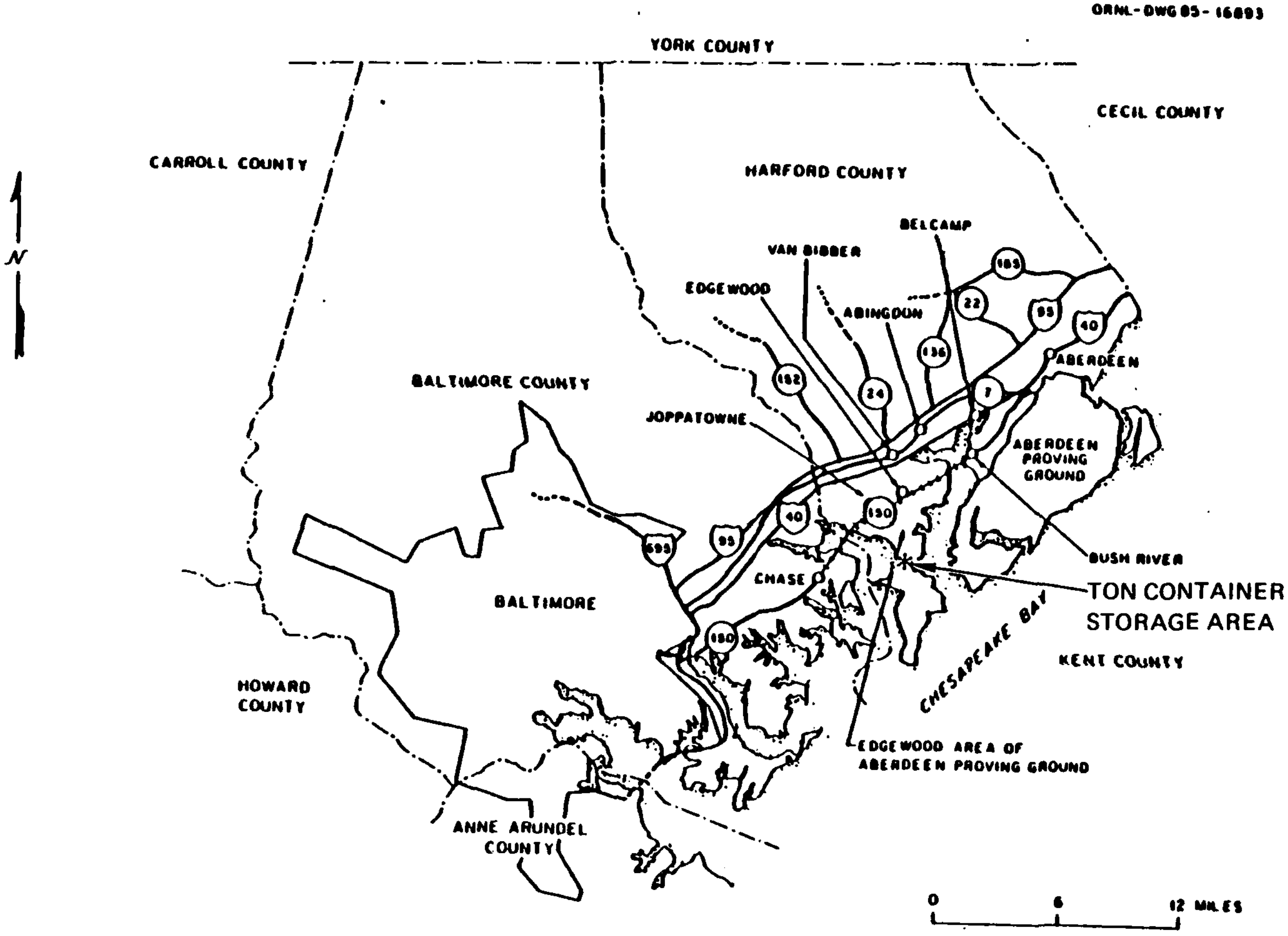

Fig. D-3. County map showing the location of APG

TABLE D-1
EARTHQUAKES IN THE VICINITY OF THE APG SITE
(Ordered By Distance From Site)

Year	Month	Day	Location	MMI	Distance from Site (km)
1883	3	11	39.5N, 76.4W	V	14
1883	3	12	39.5N, 76.4W	V	14
1883	3	12	39.5N, 76.4W	III	14
1883	3	12	39.5N, 76.4W	V	14
1939	6	22	39.5N, 76.6W	III	28
1939	11	18	39.5N, 76.6W	IV	28
1939	11	26	39.5N, 76.6W	V	28
1930	11	01	39.1N, 76.5W	IV	38
1930	11	01	39.1N, 76.5W	III	38
1906	10	13	39.2N, 76.7W	III	41
1910	04	24	39.2N, 76.7W	III	41
1758	04	25	38.9N, 76.5W	V	58
1876	01	30	38.9N, 76.5W		58
1978	07	16	39.9N, 76.2W	V	58
1984	04	19	39.9N, 76.3W	V	58
1984	04	23	39.9N, 76.3W	V	58
1910	01	24	39.6N, 77.0W	II	64
1828	02	24	38.9N, 76.7W		65
1978	10	06	39.9N, 76.5W	VI	66
1885	03	09	40.0N, 76.3W	IV	67
1939	04	02	40.0N, 76.3W	II	67
1971	07	14	39.7N, 75.6W	IV	69
1971	12	29	39.7N, 75.6W	IV	69
1972	01	02	39.7N, 75.6W	IV	69
1972	01	03	3917N, 75.6W	IV	69
1972	01	07	39.7N, 75.6W	IV	69
1972	01	22	39.7N, 75.6W	IV	69
1972	01	23	39.7N, 75.6W	IV	69
1972	01	23	39.7N, 75.6W	IV	69
1972	02	11	39.7N, 75.6W	V	69
1972	02	11	39.7N, 75.6W		69
1972	08	14	39.7N, 75.6W	IV	69
1972	08	14	39.7N, 75.6W		69
1974	04	28	39.7N, 75.6W	IV	69
1889	03	08	40.0N, 76.0W	V	71
1889	03	09	40.0N, 76.0W		71
1871	10	10	39.6N, 75.5W	IV	72
1879	03	26	39.2N, 75.5W	V	72
1902	03	10	39.6N, 77.1W	III	72
1902	03	11	39.6N, 77.1W	III	72
1903	01	01	39.6N, 77.1W	I	72
1983	11	17	39.8N, 75.6W	V	73
1983	12	12	39.8N, 75.6W		73
1871	10	09	39.7N, 75.5W	VII	76
1902	03	10	39.6N, 77.2W	III	80
1902	03	11	39.6N, 77.2W	III	80
1903	01	01	39.6N, 77.2W	III	80
1903	01	01	39.6N, 77.2W	II	80

Data provided by the National Geophysical Data Center, NOAA.

River. The storage yard consists of a central aisleway of finished concrete and the ton containers are secured over a gravel surface. There are two buildings in the CASY that are used to store equipment. Only mustard-filled ton containers are stored at APG and they are stored outdoors in accordance with AMC regulations.

The airspace above the Edgewood area of APG is continuously restricted (Restriction No. R-4001A). Permission to fly at altitudes above 10,000 ft from midnight to 7:00 AM may be requested 24 hr in advance. The Weide Army Air Field (AAF) is located within a mile of the storage area. It has a 4600-ft runway which is used by a general aviation flying club and an Air National Guard helicopter unit located at Weide AAF. The Army estimates that there are approximately 2600 general aviation operations (takeoffs/landings), 7200 helicopter operations, and 800 small fixed-wing military operations per year at Weide. There are no large aircraft operations.

Phillips AAF is located approximately 8 miles to the northeast. It has three runways. The longest is 8000 ft. The Army indicates that the edges of the approach and holding patterns for Phillips are more than 2 miles north of the storage area. Therefore, they are not considered a threat to the storage area per the guideline of Ref. D-3.

There are three other airports located in the area. Baltimore Airpark is approximately 8 miles to the west and has one 2200-ft runway. Martin State Airport is located 8 miles to the southeast. It has three runways. The longest is 7000 ft. The largest airport in the area is Baltimore Washington International Airport which is 26 miles southwest of Aberdeen. Its longest runway is 9500 ft. There are two low altitude federal airways (V378 and V499) that pass approximately 8 miles from the storage area. The closest high altitude jet routes (J42-8 and J40) are approximately 14 miles from the storage area. These airports and airways are not expected to present a significant threat to the storage

area because of the distances involved and because the storage area is protected by the restricted airspace.

D.1.2. ANNISTON ARMY DEPOT

As shown in Figs. D-4 and D-5, the Anniston Army Depot (ANAD) is located within Calhoun County in northeast Alabama adjacent to Fort McClellan, another active U.S. Army installation. ANAD is a major supply, stock distribution, and storage depot for general and strategic material, equipment, and supplies, including ammunition. Its functions also include maintenance and disposal activities associated with ammunition supply and storage, such as ammunition preservation, demilitarization, surveillance and training.

The chemical storage area at ANAD is located along the northeastern edge of the installation. The chemical storage area is divided into two adjacent areas, G-block and C-block. The ANAD chemical munition stockpile consists of all munition types except bombs and spray tanks. Munitions are stored in 40-ft, 60-ft, and 80-ft igloos. All 40-ft and 60-ft igloos are equipped with a single door, while all 80-ft igloos are equipped with a double door. The igloos are well maintained with no evidence of chronic structural problems. All igloos were re-waterproofed in 1984. The re-waterproofing involved removing the earthen covering over the igloo and sealing the concrete surface with tar. The earthen cover was then replaced to specifications.

The stockpile of chemical munitions stored at ANAD includes 105-mm cartridges, 4.2-in. mortars, 155-mm and 8-in. projectiles, 115-mm rockets, land mines, and ton containers. Documentation indicates that all of the 105-mm projectiles are stored in the cartridge configuration, packaged two cartridges per box. All munitions are stored in their standard configurations in accordance with AMC regulations.

As shown in Table D-2, five earthquakes of MMI levels V to VII have occurred in the vicinity of the ANAD site in this century.

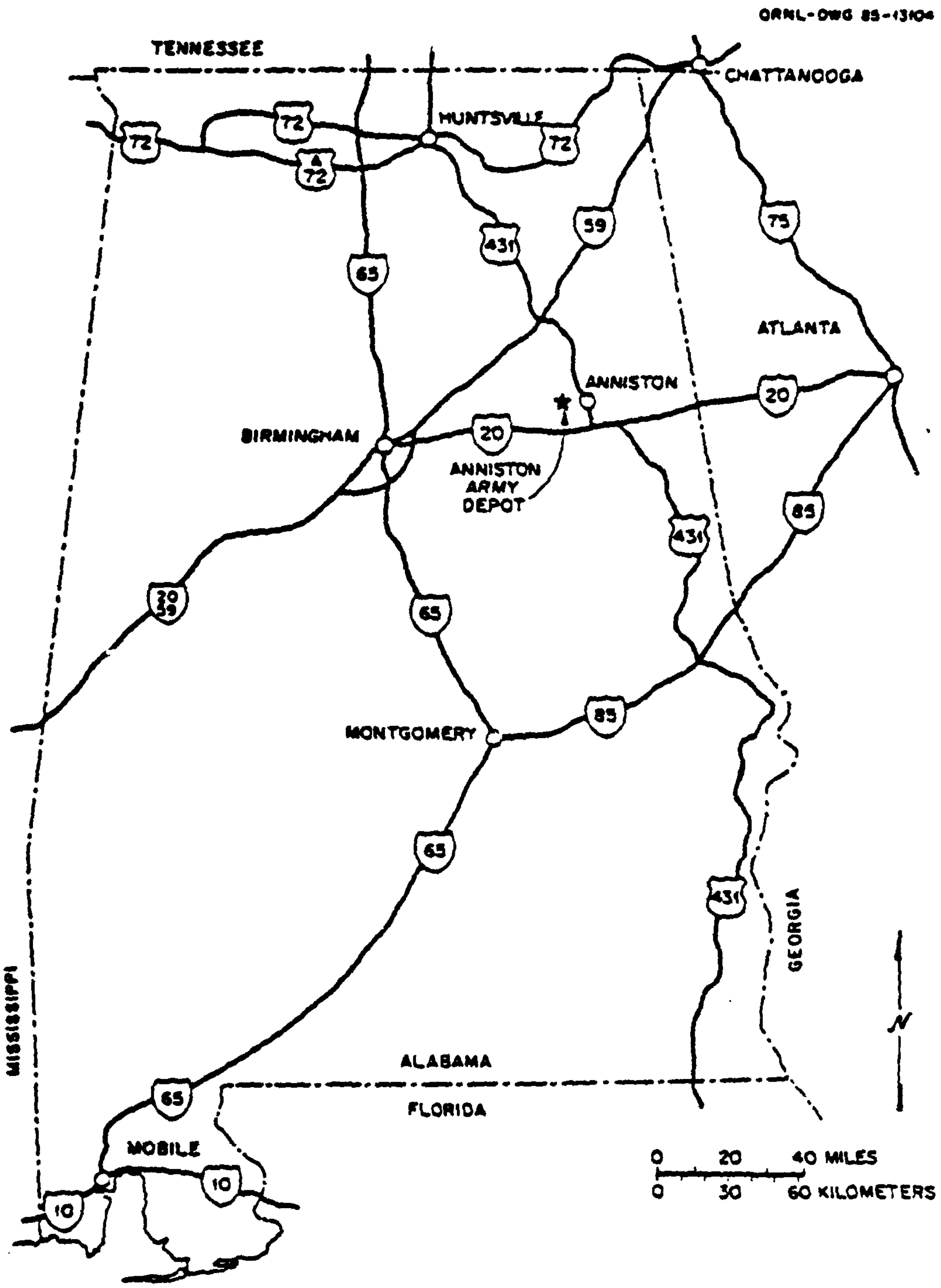

Fig. D-4. Alabama state map showing the location of ANAD

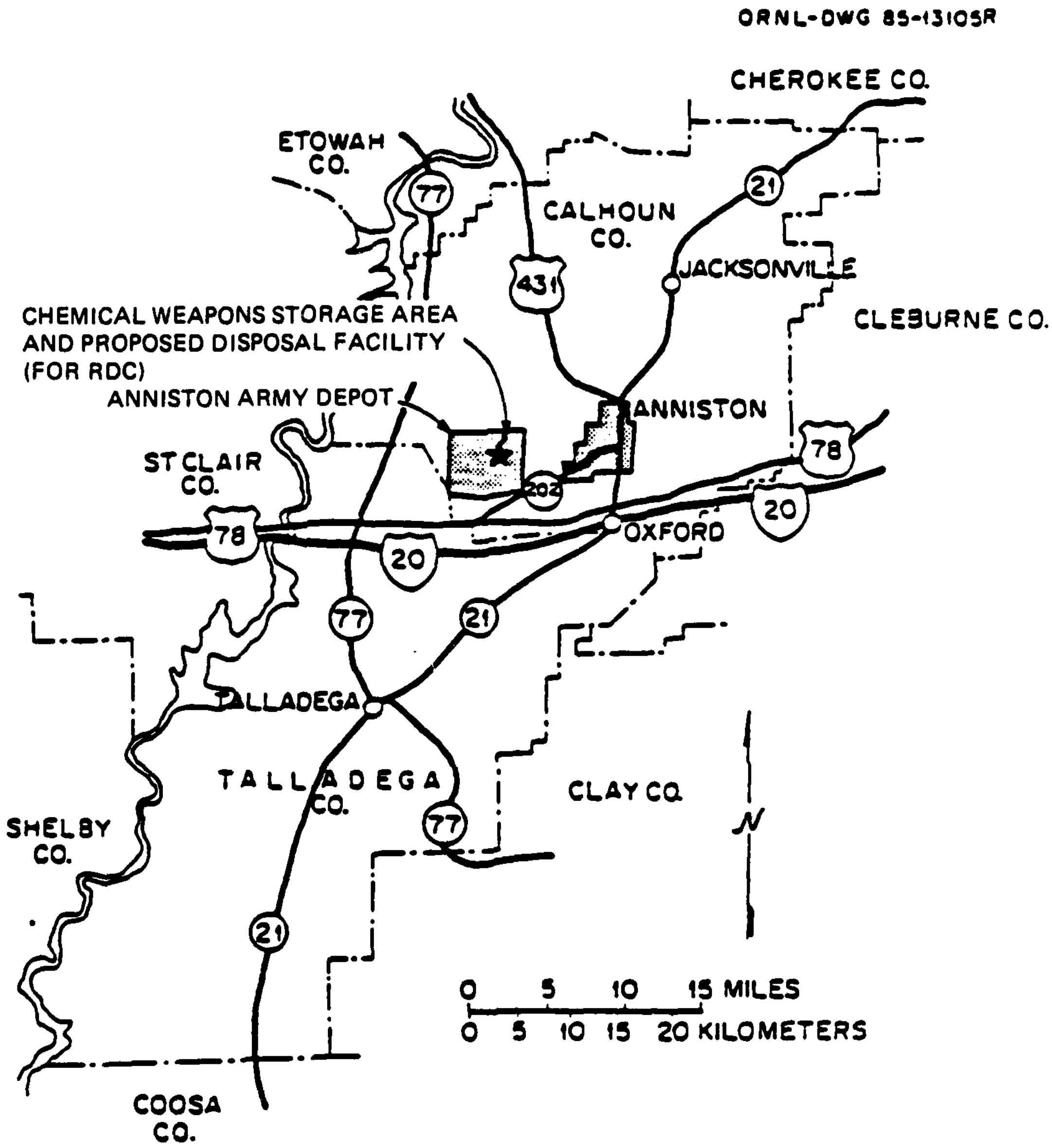

Fig. D-5. County map showing the location of ANAD

TABLE D-2
EARTHQUAKES IN THE VICINITY OF THE ANAD SITE[a]
(Chronological Listing)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1916	10	18	Irondale, AL 33.5N, 86.2W	VII
1927	6	16	Scottsboro, AL 34.7N, 86.0W	V
1931	5	5	Cullman, AL 33.7N, 86.6W	V to VI
1939	5	4	Anniston, AL 33.7N, 85.8W	V
1975	8	28	Northern, AL 33.8N, 86.6W	VI

[a]Earthquakes within a 50- to 60-mile radius of the Anniston site, abstracted from Table 2.5-2, Clinch River Breeder Reactor Plant Preliminary Safety Analysis Report. Source: Ref. D-1.

The airspace above the chemical munition storage area at the ANAD is unrestricted. The airspace just north and northeast of the chemical storage area is restricted continuously to 24,000 ft (Restriction number R-2102). The area just west of the chemical munition storage area is restricted up to a 5000-ft level from 7:00 AM to 6:00 PM Monday through Friday (Restriction number R-2101).

The closest major airfields are Anniston and Talladega, both of which are approximately 8 miles from the chemical munition storage area. Anniston has a 7000-ft runway and can accept aircraft as large as a Lockheed C-141. Air traffic flying in and out of Anniston must stay to the south of the depot (Ref. D-1). Talladega has a 6000-ft runway. It has handled Lockheed C-130s but cannot accept C-141s. Air traffic coming out of Talladega must stay west of the depot (Ref. D-1). Consequently, the edge of the flight path in and out of Anniston and out of Talladega is at least 2 miles from the storage area.

To the east and north of the city of Anniston, there are two small airports and a heliport, the closest of which is 8 miles from the storage area. Air traffic from these airports is not a significant threat to the storage area since there is 3 miles of restricted airspace between these airports and the storage area.

There is one low altitude federal airway (V18) which passes 6 miles south of the storage area and one high altitude jet route (J14-52) which passes directly above the storage area. The high altitude jet route is the preferred jet route for air traffic between Atlanta and Denver (Ref. D-2). Military training route IR69 passes over the storage area and then returns three miles south of the storage area.

D.1.3. LEXINGTON-BLUE GRASS ARMY DEPOT

As shown in Figs. D-6 and D-7, the Lexington-Blue Grass Army Depot (LBAD) is located in Madison County, south of Richmond, Kentucky. The primary mission of the depot is to operate a general supply and ammunition depot activity providing for the receipt, storage, issue, maintenance, demilitarization, and disposal of assigned commodities.

The chemical munition storage area at LBAD is located in the north central half of the Blue Grass facility. The chemical munition stockpile at LBAD consists of 8-in. projectiles, 155-mm projectiles, and M55 rockets. These munitions are stored in 89-ft oval-arch igloos. Seventy-five percent of the igloos were waterproofed in 1982. The procedure involved removing the earth covering the igloo to apply a layer of tar, and then replacing the earthen cover.

Table D-3 summarizes earthquake activity in the vicinity of the LBAD site.

LBAD airspace is not restricted. There are three small airfields in the vicinity of the depot: Madison County Airport, Berea Richmond Airfield, and Galla Airfield. Madison County Airport is approximately 9 miles from the storage area. At the Madison County Airport, there is a civilian flight school which operates light aircraft, ranging from single engine light planes up to twin engine aircraft. The flight school uses two training areas near the depot, one to the north and the other to the east. The Madison County airport has a 4000-ft runway. The Berea Richmond Airfield is approximately 6 miles from the storage area and can support only light aircraft on its 2400-ft grass strip runway. Galla is a small, private airfield 12 miles east of the storage area. The air traffic from these airports over the storage area is not expected to be a significant hazard.

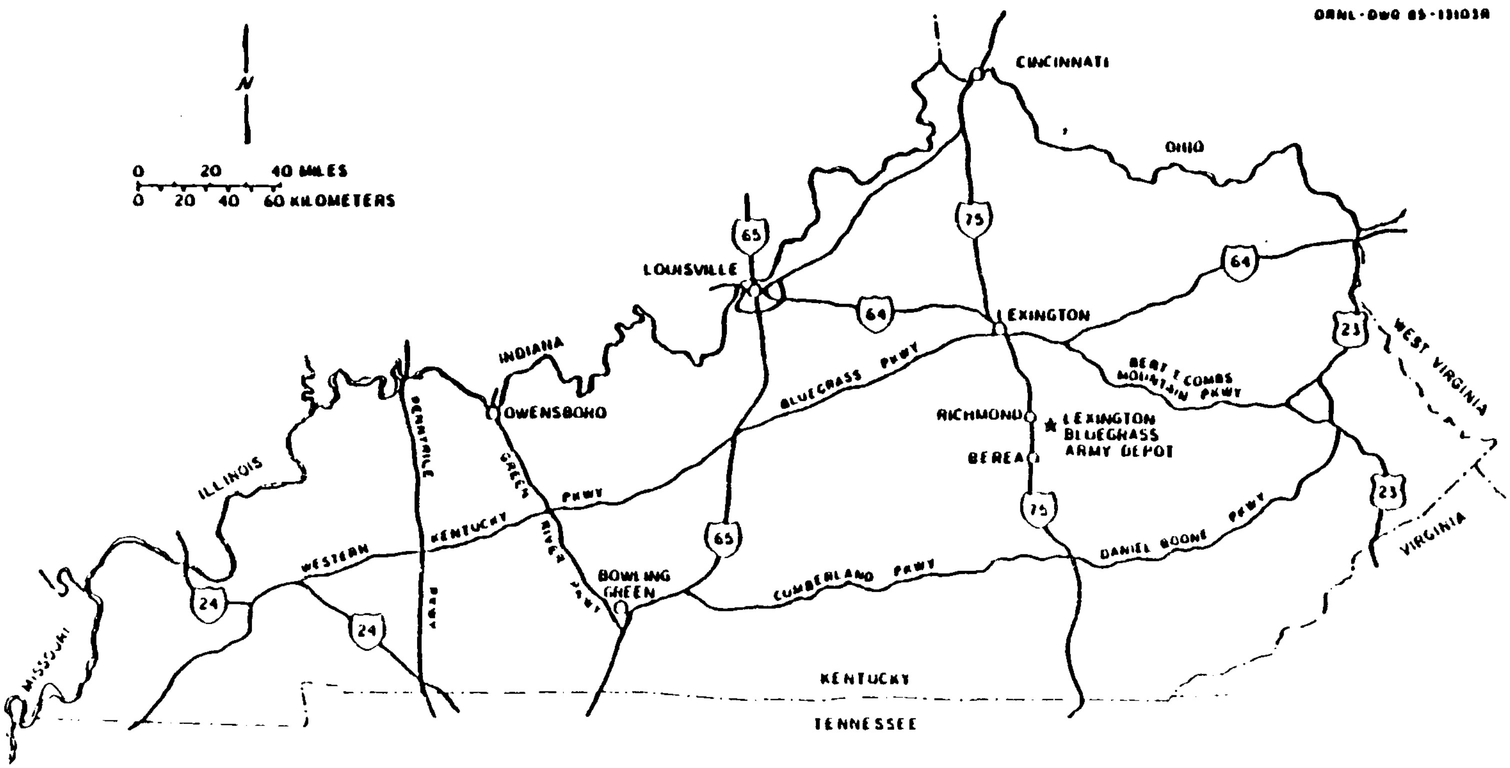

Fig. D-6. Kentucky state map showing the location of LBAD

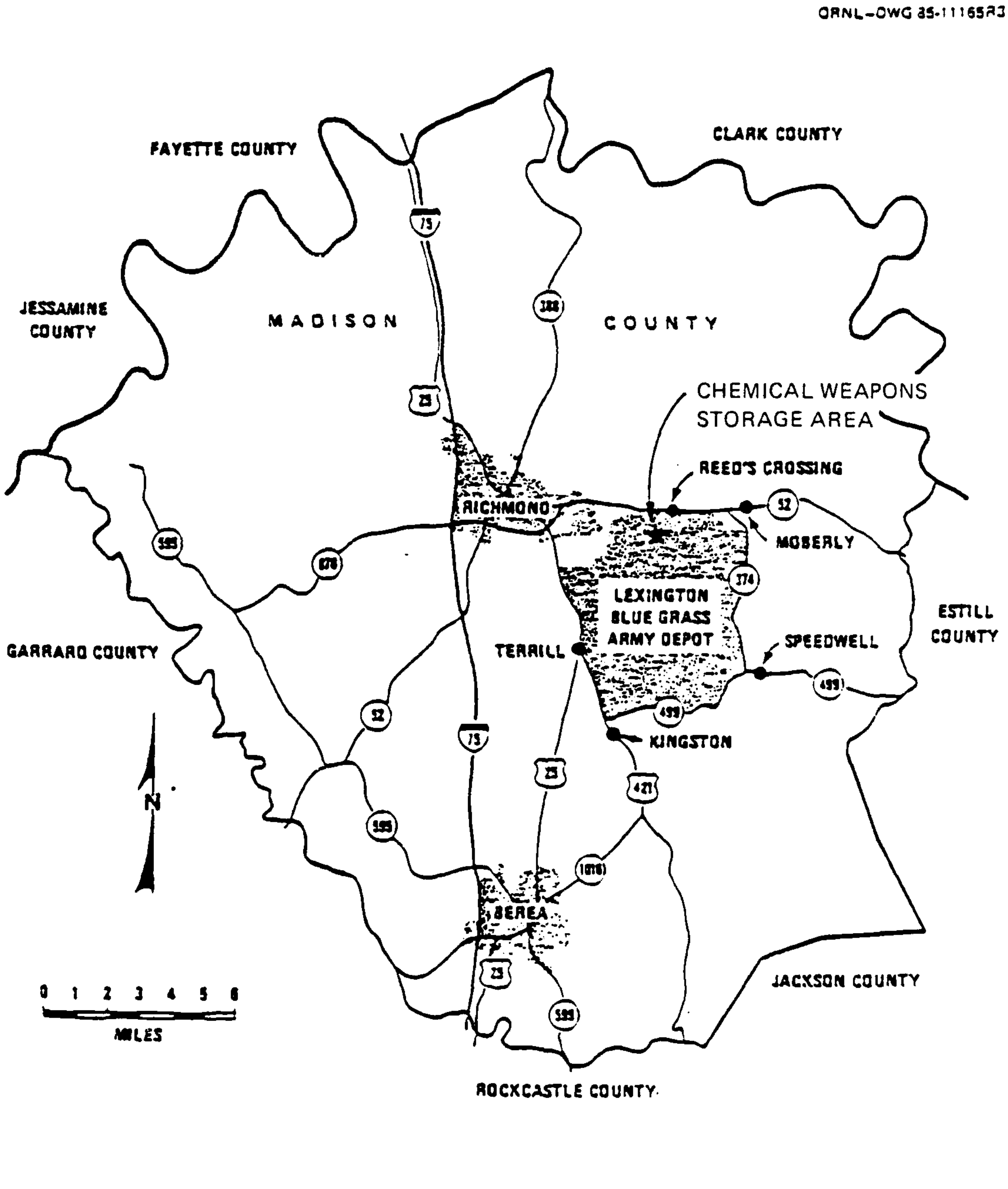

Fig. D-7. Madison county map showing the location of LBAD

TABLE D-3
EARTHQUAKES IN THE VICINITY OF THE LBAD SITE[a]
(Chronological Listing)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1779	1	1	Kentucky 38.0N, 84.0W	Unknown
1834	11	20	Northern KY 37.0N, 86.0W	V
1933	5	28	Maysville, KY 38.7N, 83.7W	V
1954	1	1	Middlesboro, KY 36.6N, 83.7W	VI
1968	12	11	Louisville, KY 38.0N, 85.5W	V
1974	6	4	Kentucky 38.6N, 84.77W	V (est)
1976	1	19	Kentucky 36.88N, 83.82W	VI
1979	11	9	NE Kentucky 38.42N, 82.88W	V (est)
1980	6	27	Kentucky 38.17N, 83.91W	VII
1980	8	2	Kentucky 37.99N, 84.92W	III
1980	8	22	Kentucky 37.99N, 84.92W	III

[a]Earthquakes within a 50- to 60-mile radius of the Lexington-Blue Grass Site, abstracted from Table 2.5-2, Clinch River Breeder Reactor Plant Preliminary Safety Analysis Report. Source: Ref. D-1.

There is a U.S. Air Force radar bombing/scoring detachment stationed at the LBAD with frequent flights (10 to 11 aircraft per day) of Air Force B-52, F-4, and F-111 aircraft at low altitudes (750 and 3000 ft). The flights are active from 11:30 AM to 3:30 PM and from 6:00 PM until midnight every day. They fly at 750 ft under visual flight rules and at 2000 to 3000 ft under instrument rules with a visual observer. Generally, they make three simulated bombing runs per flight at distances at least 2 miles away from the chemical exclusion area. Per the guidelines of Ref. D-3, this is not expected to be a significant problem.

D.1.4. NEWPORT ARMY AMMUNITION PLANT

The Newport Army Ammunition Plant (NAAP) is located in west central Indiana, west of Indianapolis, as shown in Figs. D-8 and D-9. NAAP is operated by Mason & Hangar. The mission of NAAP is to (1) manufacture explosive and chemical materials, (2) fill chemical munitions, and (3) to store chemical munitions. Items 1 and 2 are currently inactive, while item 3 involves the activities associated with storage of VX chemical agent ton containers.

The chemical storage area at NAAP includes a single storage warehouse (Building 144) that is used to house VX ton containers. The storage building is approximately 79 ft wide and 279 ft long. The walls and roof of the building are of heavy gauge corrugated sheet metal, supported by steel beams.

The warehouse is in an exclusion area adjacent to the former VX production facility. The grounds within the exclusion area are all concrete or macadam covered surfaces. There are several large storage tanks that were used to store agent which are located along the southeast side of the warehouse. These storage tanks are currently empty. A 409-ft tall flash tower is located 450 ft to the east of Building 144. The flash tower was utilized during production of VX to burn several flammable gas by-products. Just outside the exclusion area, approximately 560 ft to the east of Building 144, is the site of a natural gas metering station. Natural gas was distributed to the production plant and to the area boiler from this point. Several empty storage vessels are located approximately 350 ft from the nearest ton containers outside the exclusion area. These tanks were used in conjunction with the former VX production facility. These tanks are to remain empty during the demilitarization campaign.

Table D-4 summarizes earthquake activity in the vicinity of the NAAP site.

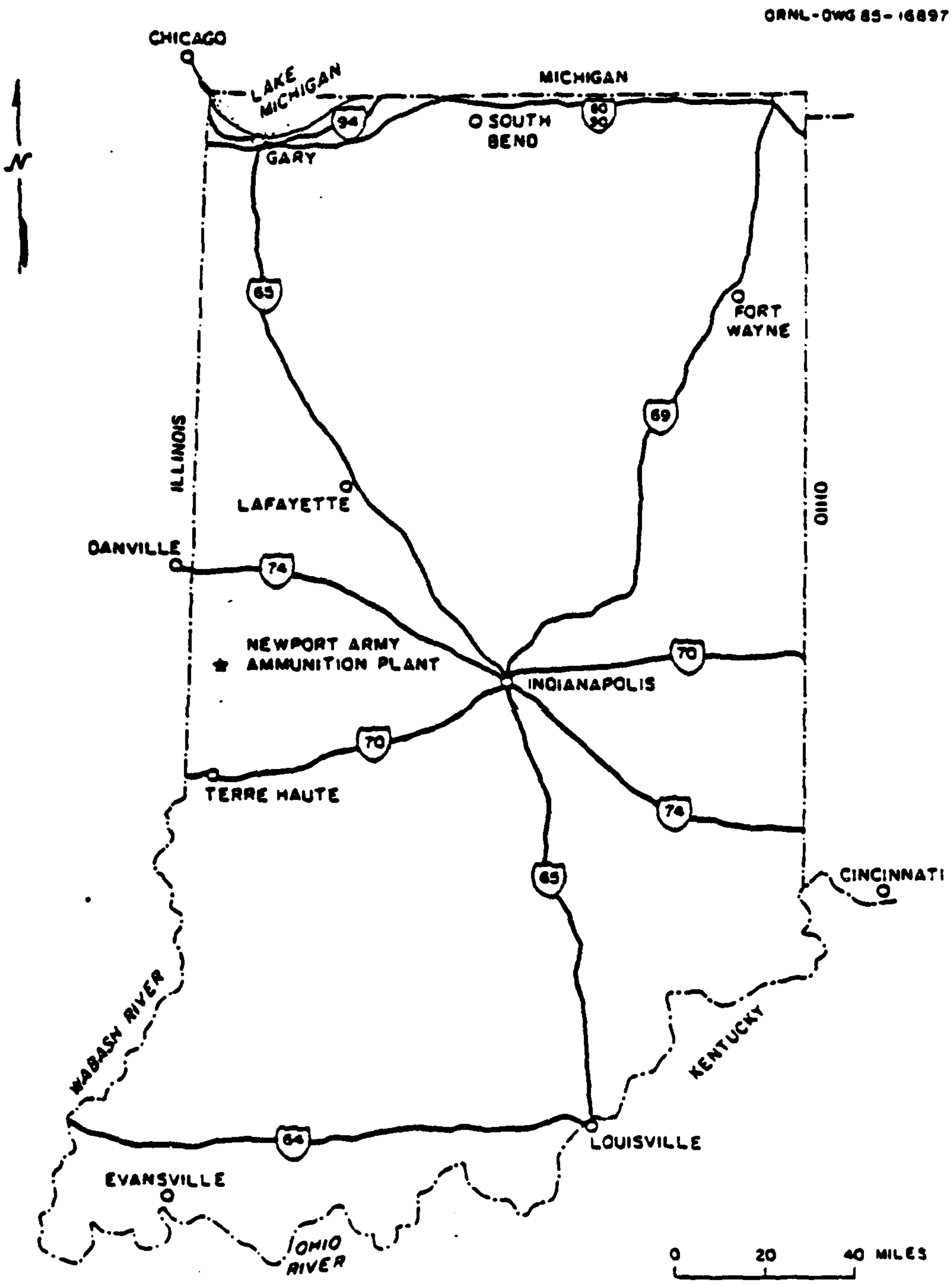

Fig. D-8. Indiana state map showing the location of NAAP

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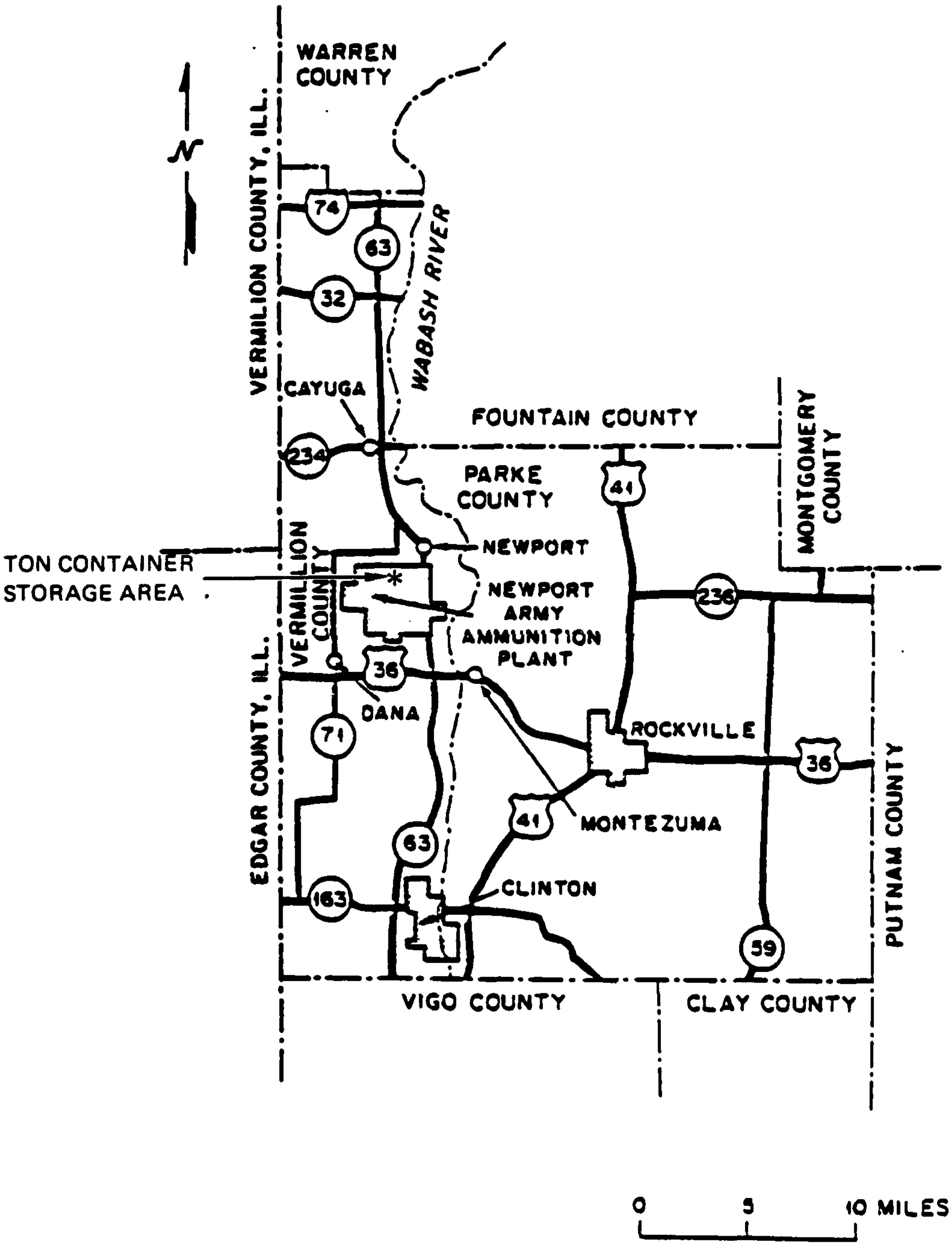

Fig. D-9. County map showing the location of NAAP

The airspace at NAAP is not restricted. The only airport within a 10-mile radius of the plant is a private airstrip (Rowe) with a 2600-ft runway located 8 miles west of the plant. The nearest public airport is Clinton which is approximately 12 miles south of the plant. Low altitude federal airway V171 passes 2 miles east of the storage area and airway V434 passes 5 miles north of the storage area. High altitude jet routes J80 and J73 cross over the storage area.

TABLE D-4
EARTHQUAKES IN THE VICINITY OF THE NAAP SITE
(Ordered By Distance From Site)

Year	Month	Day	Location	MMI	Distance from Site (km)
1909	9	27	39.5N, 87.4W	VII	41
1921	3	14	39.5N, 87.5W	IV	41
1903	12	31	40.0N, 87.9W		42
1974	11	25	40.3N, 87.4W	II	48
1906	7	13	39.7N, 86.8W		57
1906	8	13	39.7N, 86.8W	IV	57
1984	8	29	39.3N, 87.2W	V	58
1978	2	16	39.8N, 88.23W		68
1984	7	28	39.2N, 87.1W	V	78

Data provided by the National Geophysical Data Center, NOAA.

D.1.5. PINE BLUFF ARSENAL

As shown in Figs. D-10 and D-11, the Pine Bluff Arsenal (PBA) is located southeast of Little Rock, Arkansas and northwest of the city of Pine Bluff, Arkansas. The primary missions include storage of conventional and chemical munitions, destruction of nontoxic chemicals, and production of smoke munitions, white phosphorus projectiles and other incendiary devices. Future responsibilities include demilitarization of the BZ stockpile and production of binary chemical munitions.

The chemical storage area at PBA is located in the northwestern section of the installation. The following munitions are stored at PBA: 4.2-in. mortar projectiles, M55 rockets, land mines, and ton containers. All munitions except ton containers are stored in 80-ft igloos. Ton containers containing mustard agent are stored outdoors in a fenced area within the chemical storage area. The ton containers are strapped to railroad rails and stacked one high per AMC regulations.

Table D-5 summarizes earthquake activity in the vicinity of the PBA site.

PBA airspace is not restricted. The closest important airfield, Grider Field, is about 16 miles southeast of the chemical munition storage area. There are three smaller airfields which are closer (10 to 14 miles). Because of the relatively significant distances from airfields, PBA is not considered to have a significant hazard due to airfield operations.

Grider handles approximately 115 aircraft movements per day, seven days a week. About 95% of this traffic is corporate/civilian, and the remainder is military. The runway at Grider Field is 6,000 ft and can occasionally accommodate commercial 727 and military C-141 aircraft. Low altitude federal airways V74, V305, and V16 pass within 7, 10, and 11 miles, respectively. High altitude airway J42 passes over the site.

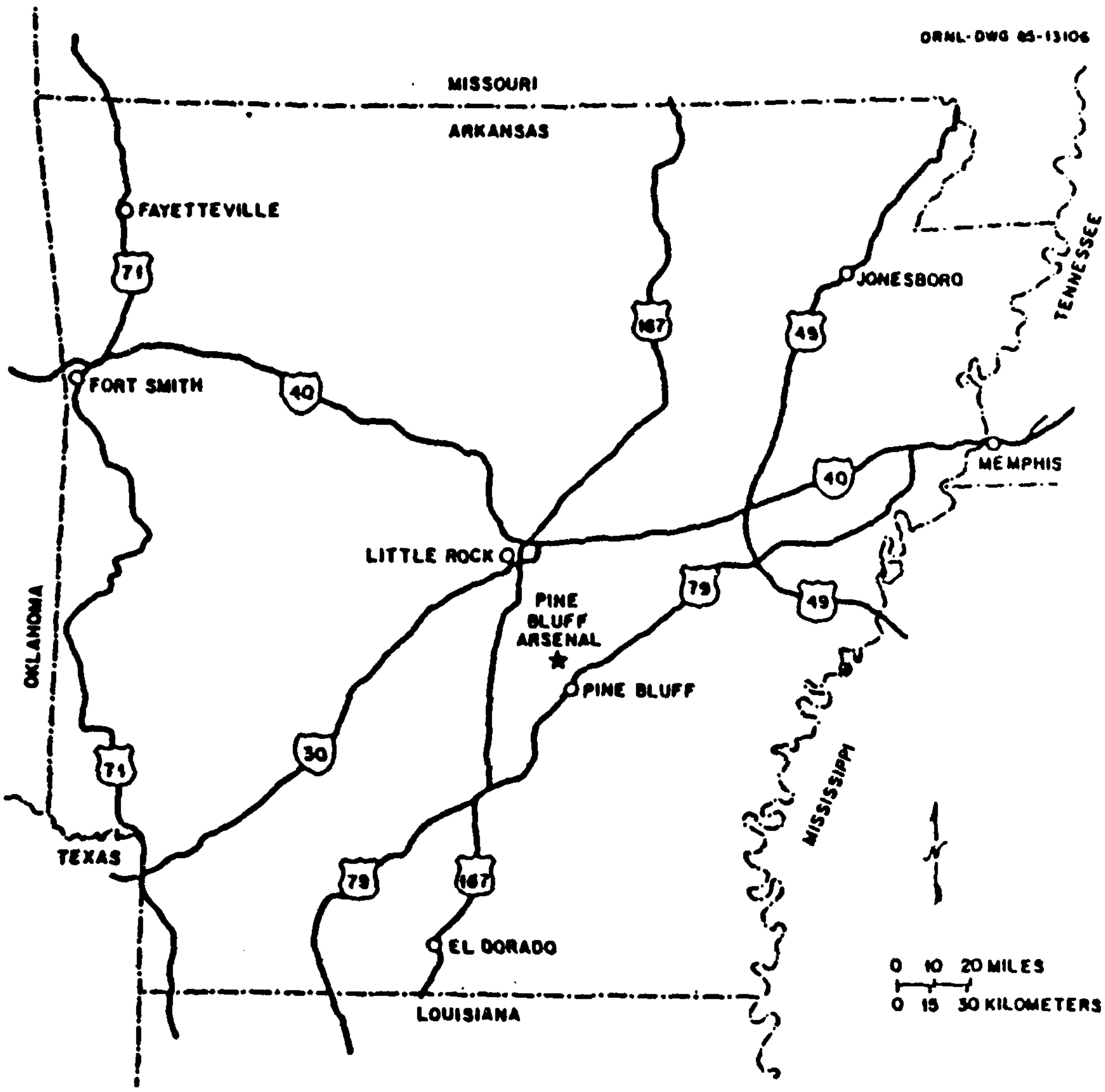

Fig. D-10. Arkansas state map showing the location of PBA

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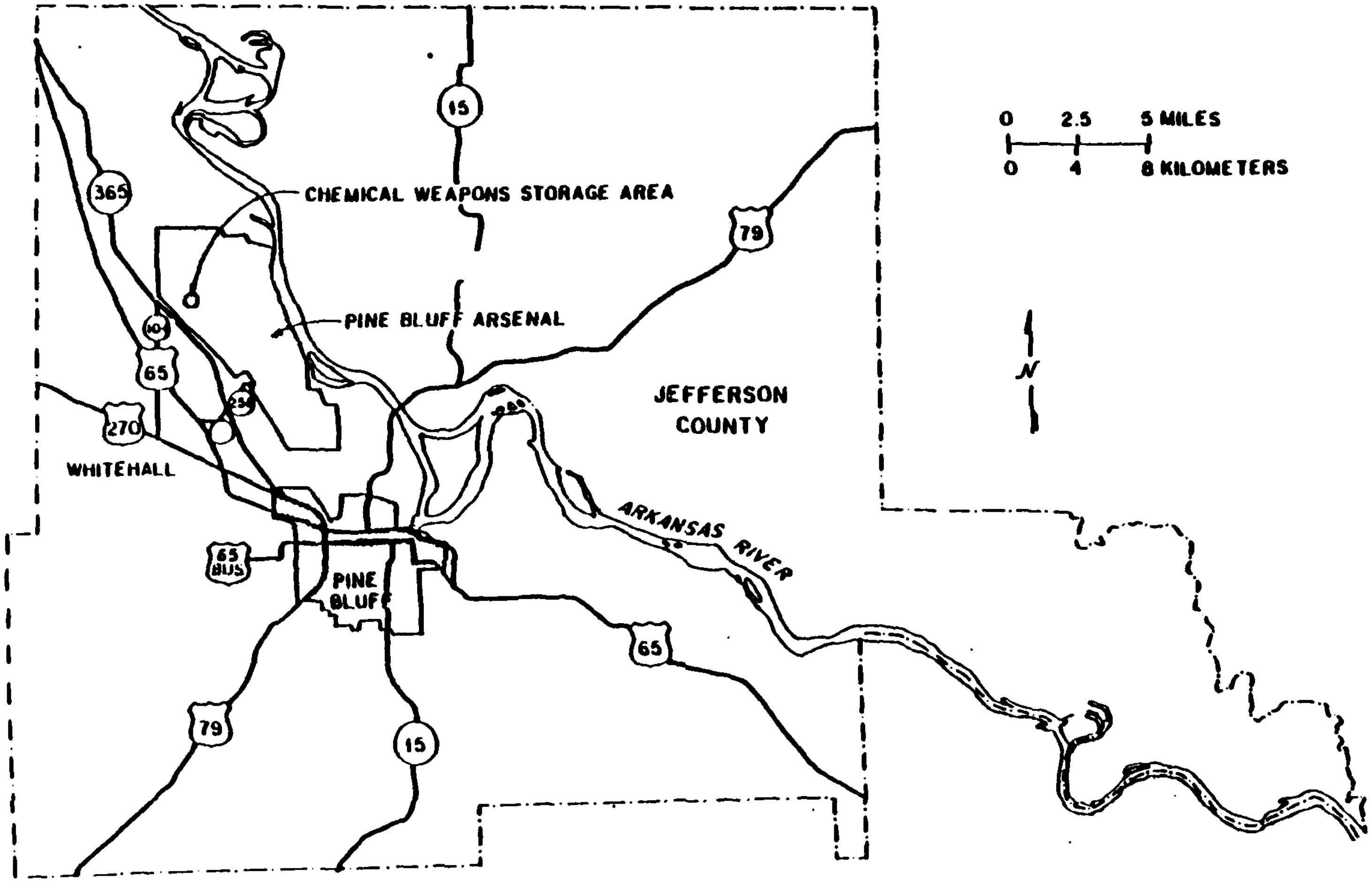

Fig. D-11. County map showing the location of PBA

There is a helipad onsite about 2 miles away from the chemical munition storage area boundary. The flight frequency was estimated to be 30 or less flights a month (Ref. D-1).

TABLE D-5
EARTHQUAKES IN THE VICINITY OF THE PBA SITE[a]
(Chronological Listing)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1911	3	31	33.8N, 92.2W	VI
1918	10	4	34.7N, 92.3W	V
1930	11	16	34.3N, 92,8W	V
1939	6	19	34.1N, 93.1W	V
1967	6	4	33.5N, 90.8W	VI
1967	6	29	33.5N, 90.8W	V
1969	1	1	34.3N, 92.6W	VI
1974	2	15	33.9N, 93.0W	V
1974	12	13	34.5N, 91.8W	V
1978	9	23	33.6N, 91.89W	V
1982	1	21	35.1N, 92.2W	V
1982	1	24	35.2N, 92.2W	V
1982	2	24	35.1N, 92.2W	V
1982	3	1	35.1N, 92.2W	V
1983	1	19	35.1N, 92.2W	V

[a]Earthquakes within a 100 mile (160 km) radius of the Pine Bluff site as provided by the National Geophysical Data Center, NOAA. Records believed to be duplicates are reported only once. Source: Ref. D-1.

D.1.6. PUEBLO DEPOT ACTIVITY

The Pueblo Depot Activity (PUDA) is under the command of the Tooele Army Depot. As shown in Figs. D-12 and D-13, the installation lies east of the city of Pueblo, Colorado and north of the Arkansas River. The mission of PUDA facilities is to operate a reserve storage and maintenance function providing for (1) limited receipt, storage, and issue of assigned commodities; (2) depot maintenance of assigned commodities; (3) limited maintenance of facilities to prevent deterioration of the ammunition stockpile; (4) operation of a calibration service for an assigned geographical area; (5) demilitarization and disposal of deteriorated explosives and munitions; (6) ammunition surveillance; (7) small arms clipping and linking; (8) operation of the Function/Trace Test Range; and (9) missile maintenance/production.

The chemical storage area at PUDA is located in the northeast corner of the depot in the G-block storage area. The following munitions are stored at PUDA: 155-mm projectiles, 105-mm cartridges and projectiles, and 4.2-in. mortar projectiles. All munitions are stored in 80-ft igloos.

Table D-6 summarizes earthquake activity in the vicinity of the PUDA site.

The airspace at the PUDA is not restricted. There is a private airport (Youtsey) a few miles south of the depot. The nearest public airport is Pueblo Memorial which is located 6 miles west of the boundary of the depot. This airport has four runways, the longest being 10,500 ft. Pueblo Memorial is used as a training airport for both commercial and military aircraft. Low altitude federal airways V10, V19, V81, V83, V244, and V389 all pass within a few miles of the depot, as do high altitude jet routes J17 and J28.

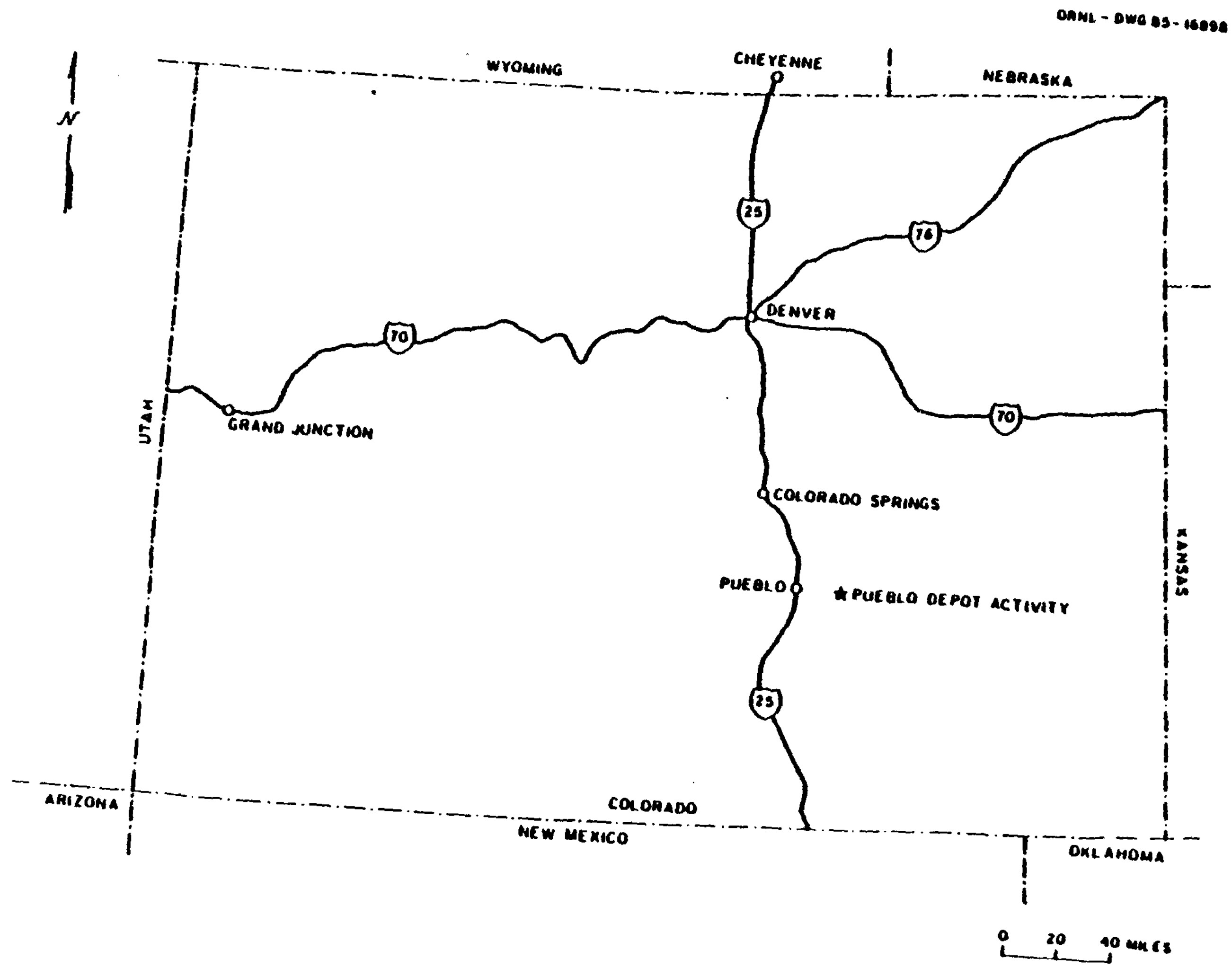

Fig. D-12. Colorado state map showing the location of PUDA

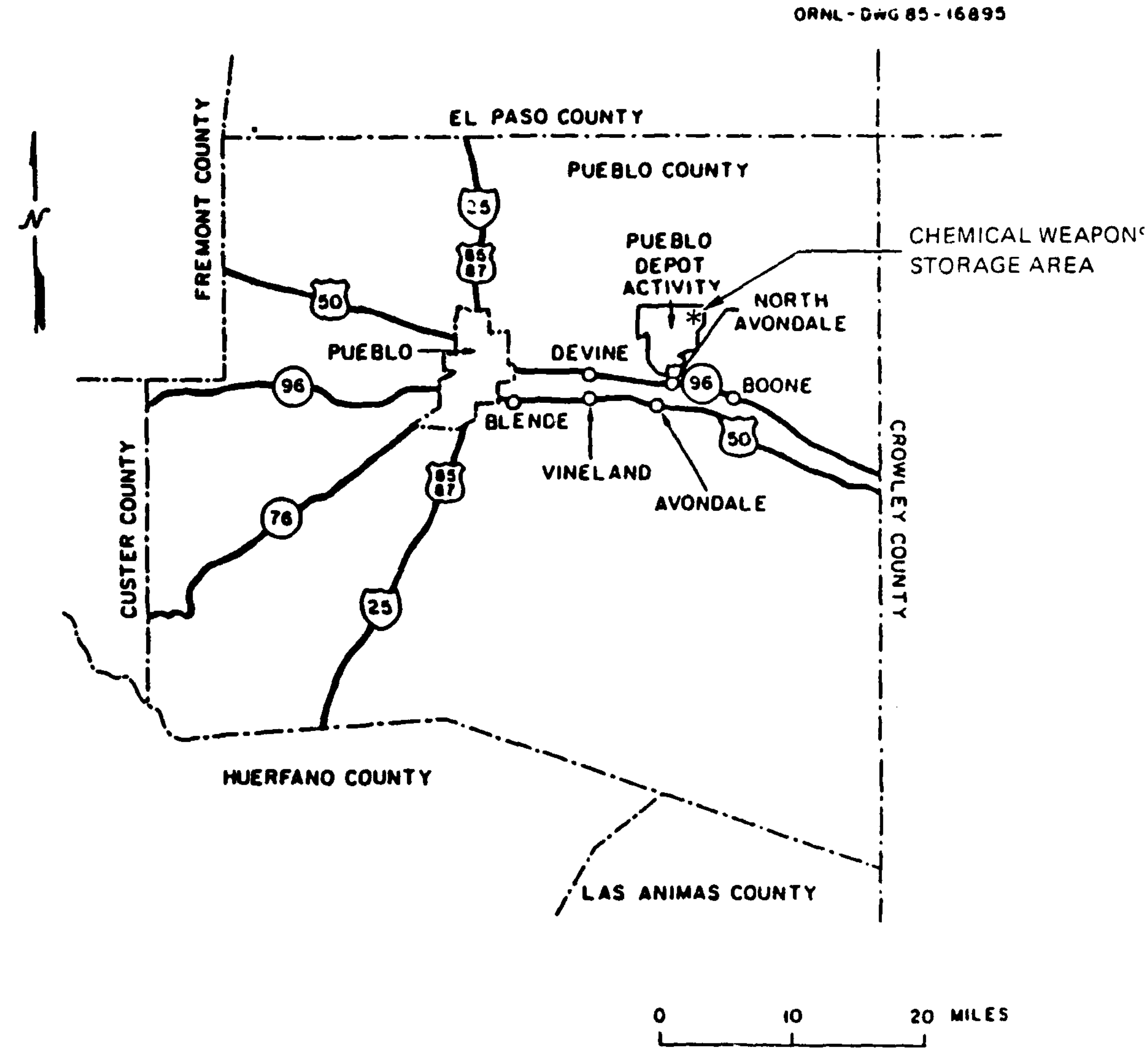

Fig. D-13. County map showing the location of PUDA

TABLE D-6
EARTHQUAKES IN THE VICINITY OF THE PUDA SITE
(Ordered By Distance From Site)

Year	Month	Day	Location	MMI	Distance from Site (km)
1963	11	13	38.3N, 104.6W	IV	22
1870	12	4	38.5N, 104.0W	VI	37
1955	11	28	38.2N, 103.7W	IV	58
1925	2	18	38.2N, 105.1W	IV	67
1888	10	23	38.1N, 105.2W	IV	78

Data provided by the National Geophysical Data Center, NOAA.

D.7. TOOELE ARMY DEPOT

The Tooele Army Depot (TEAD) is located in north central Utah southwest of Salt Lake City as shown in Figs. D-14 and D-15. The Army Depot consists of two separate areas, North and South. The chemical agent storage and demilitarization operations are located in the South Area. The mission of TEAD is to operate a supply depot providing for receipt, storage issue, maintenance and disposal of assigned commodities; and to operate other facilities such as the Chemical Agent Munitions Disposal System (CAMDS).

The chemical storage area at TEAD is located in the center of the south area. There are storage magazines, warehouse buildings, and several storage yards within the chemical agent exclusion area. The storage magazines include both 89-ft oval-arch magazines and 80-ft igloo magazines. M55 rockets, 155-mm and 8-in. projectiles, 105-mm cartridge projectiles, 4.2-in. mortar projectiles, GB and VX ton containers, M23 land mines, and weteye bombs are stored in the 80-ft igloos. MC-1 bombs, 155-mm and 105-mm projectiles are stored in the 89-ft oval-arch magazines. Ton containers containing mustard are stored outdoors. The two warehouse buildings currently are used to store VX spray tanks packaged inside TMU-28/B storage and shipping containers.

The warehouse buildings are flat-roofed, single-story structures approximately 188 ft long, 179 ft wide, and 16 ft high. Details of construction are shown in Army Corps of Engineers Drawing 201-25-65. The side walls of the buildings are single piece precast concrete panels 6 in. thick, 16 ft high, with widths varying around 30 ft. The roof is of corrugated sheet metal, supported by a steel beam support structure and steel box beam vertical support columns. The main beams are W24 x 68 steel I-beams with unsupported spans of about 30 ft. Open trusses are used to span between the main beams.

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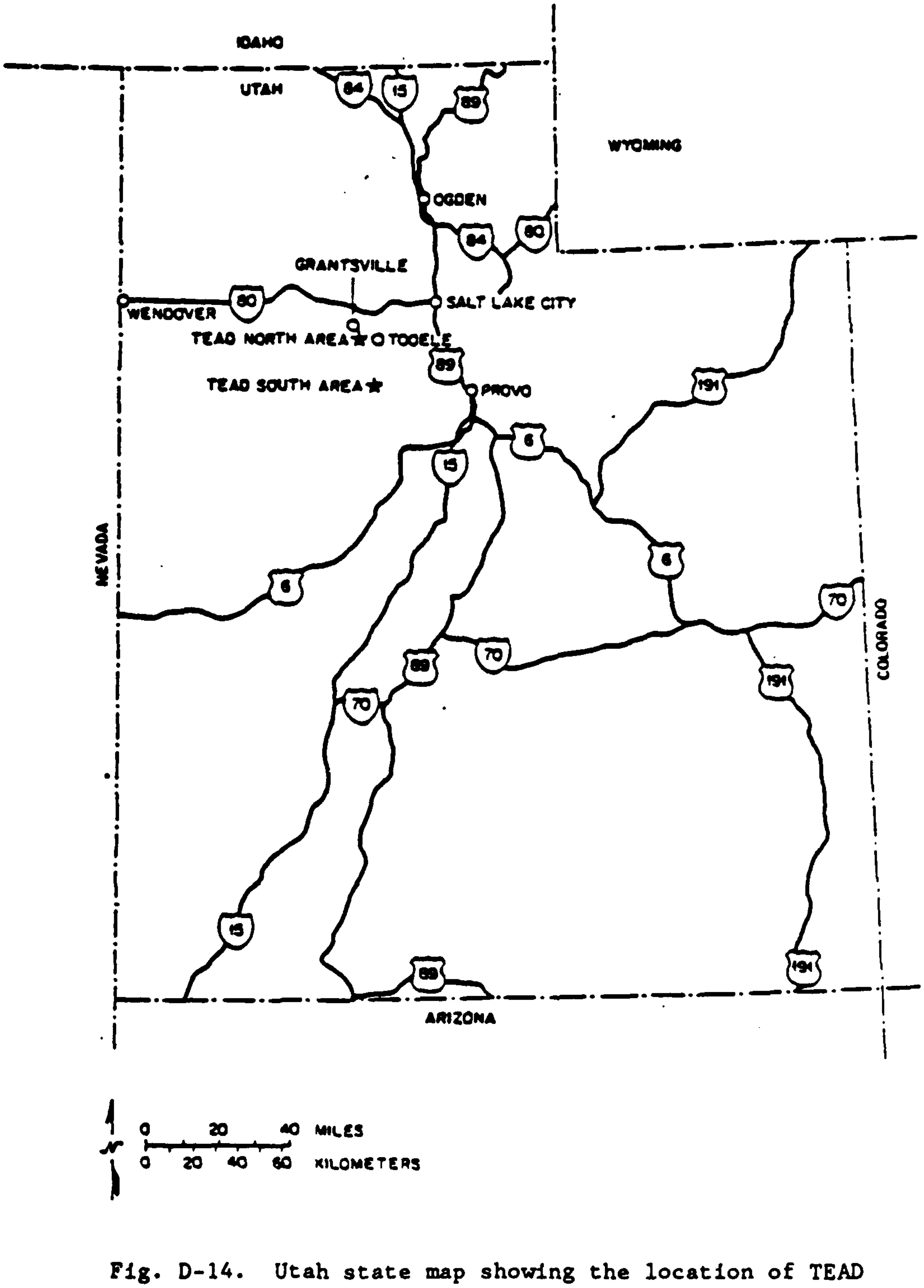

Fig. D-14. Utah state map showing the location of TEAD

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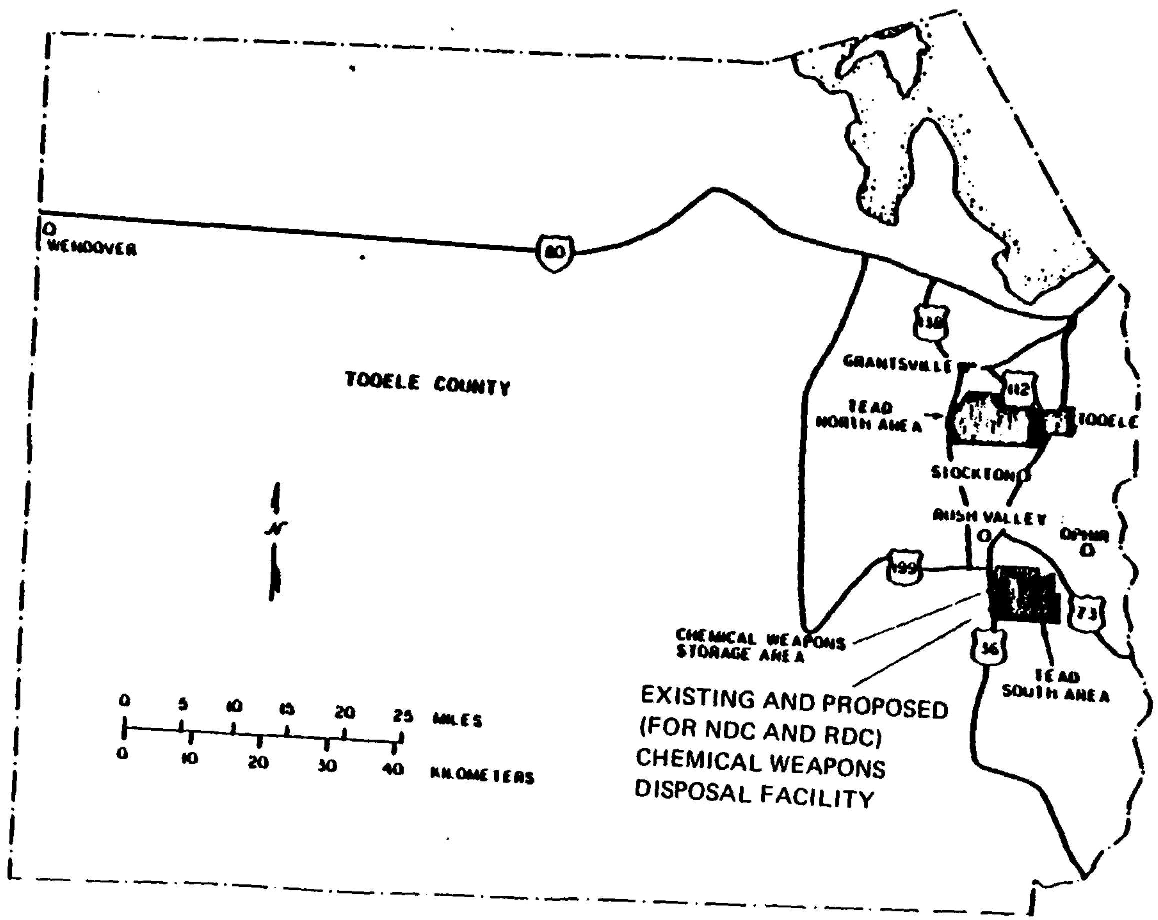

Fig. D-15. Tooele county map showing the location of TEAD

Table D-7 summarizes earthquake activity in the vicinity of the TEAD site.

The airspace over the TEAD South Area is not restricted but pilots are requested (for reasons of national security) to avoid flying below 6400 ft over this area for a radius of 3 nautical miles (3.5 statute miles).

Tooele Municipal Airport is the nearest airport to the site. It is located 14 miles north of the site and is not expected to present a significant hazard.

There are two low altitude federal airways in the vicinity of the TEAD South Area: V257, three miles to the west, and V253, 17 miles to the northeast. High altitude airways are not considered a hazard for this site.

There is a helipad located near the administrative building approximately 3 miles from the chemical munition storage area. The helipad is used infrequently. The number of flights per month is estimated to be 15.

TABLE D-7
EARTHQUAKES IN THE VICINITY OF THE TEAD SITE[a]
(Chronological Listing)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1853	12	1	39.7N, 111.8W	V
1876	3	22	39.5N, 111.5W	VI
1880	9	17	40.8N, 112.0W	V
1884	11	10	40.8N, 111.9W	VIII
1894	1	8	39.7N, 113.4W	V
1894	6	8	39.9N, 113.4W	V
1894	7	18	41.2N, 112.0W	VII
1899	12	13	41.0N, 112.0W	V
1900	8	1	39.8N, 112.2W	VII
1906	5	24	41.2N, 112.0W	V
1909	11	17	41.7N, 112.2W	V
1910	5	22	40.8N, 111.9W	VII
1914	4	8	41.2N, 111.6W	V
1915	7	15	40.3N, 111.7W	VI
1915	7	30	41.7N, 112.1W	V
1915	8	11	40.5N, 112.7W	V
1915	10	5	40.1N, 114.0W	V
1916	2	5	40.0N, 111.7W	V
1920	9	18	41.5N, 112.0W	VI
1920	9	19	41.5N, 112.0W	VI
1920	11	20	41.5N, 112.0W	VI
1934	3	12	41.5N, 112.5W	VIII
1934	4	14	41.5N, 112.5W	
1934	5	6	41.7N, 113.0W	
1938	7	9	40.5N, 111.6W	V
1938	6	30	40.5N, 111.6W	VI
1943	2	22	40.4N, 111.8W	VI
1947	3	7	40.5N, 111.6W	V
1949	3	7	40.5N, 111.6W	V
1950	5	8	40.0N, 111.5W	V
1951	8	12	40.2N, 111.4W	V
1952	9	28	40.3N, 111.5W	V
1953	5	24	40.5N, 111.5W	VI
1955	2	4	40.5N, 111.6W	V
1955	5	12	40.4N, 111.6W	V
1958	2	13	40.5N, 111.5W	VI
1958	11	28	39.4N, 111.5W	V
1958	12	1	40.5N, 112.5W	V
1958	12	2	40.5N, 112.5W	V
1961	4	16	39.1N, 111.5W	VI
1962	9	5	40.7N, 112.0W	VI
1963	7	7	39.6N, 111.9W	VI
1963	7	9	40.0N, 111.2W	
1963	7	10	39.9N, 111.4W	V
1965	5	11	41.0N, 111.5W	

TABLE D-7 (Continued)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1966	5	23	39.2N, 111.4W	
1967	2	16	41.3N, 113.3W	V
1967	9	24	40.7N, 112.1W	V
1967	12	7	41.3N, 111.7W	V
1968	1	16	39.3N, 112.2W	V
1968	11	17	39.5N, 110.9W	V
1969	5	23	39.0N, 111.8W	V
1970	4	14	39.6N, 110.7W	V
1970	10	25	39.1N, 111.3W	V
1972	10	1	40.5N, 111.3W	VI
1972	10	16	40.4N, 111.0W	V
1973	7	16	39.1N, 111.5W	V
1977	11	28	41.3N, 111.6W	V
1978	2	28	40.7N, 112.2W	V
1978	3	9	40.7N, 112.0W	VI
1978	3	13	40.7N, 112.0W	V
1980	5	24	39.9N, 111.9W	V
1981	2	20	40.3N, 111.7W	V
1981	5	14	39.4N, 111.0W	V
1983	10	8	40.7N, 111.9W	VI

[a]Earthquakes within a 100-mile radius of TEAD as provided by the National Data Center, NOAA. Records believed to be duplicated are reported only once. Source: Ref. D-1.

D.1.8. UMATILLA DEPOT ACTIVITY

The Umatilla Depot Activity (UMDA) is under the command of TEAD. As shown in Figs. D-16 and D-17, the installation is located in Umatilla and Marrow Counties in northeastern Oregon, near the south shore of the Columbia River, west of Hermiston, Oregon. UMDA's mission is to operate a reserve storage depot activity under the command of TEAD providing care and preservation for and minor maintenance of assigned commodities.

The storage area is located at the northern edge of the installation. Eighty-foot igloo magazines and warehouses are used to store the chemical munition stockpile of 155-mm and 8-in. projectiles, M55 rockets, M23 land mines, bombs, spray tanks, and ton containers. Warehouses are used to store ton containers containing mustard agent. The magazines are spaced 400 ft apart.

The warehouses are butler type buildings connected by a roof with a steel structure and aluminum siding (single sheet). The two buildings are defined as transitory structures, approximately 154 ft wide (total for both buildings) and 300 ft long.

Table D-8 summarizes earthquake activity in the vicinity of the UMDA site.

The UMDA airspace is not restricted. The nearest active airfield to the Umatilla site is Hermiston Municipal Airport approximately 12 miles from the depot. With one 4000-ft runway, its capabilities are limited to aircraft up to the size of corporate jets. The Tri-Cities Airport in Pasco, Washington, with a maximum runway length of 7700 ft, is approximately 30 miles from the depot. In general, it does not handle military aircraft. There is also a paved runway on the UMDA site capable of handling small aircraft up to the size of a Beech U-21 light utility aircraft. The nearest military airfields are in Spokane, Washington; Moses Lake, Washington; and Mt. Home, Idaho.

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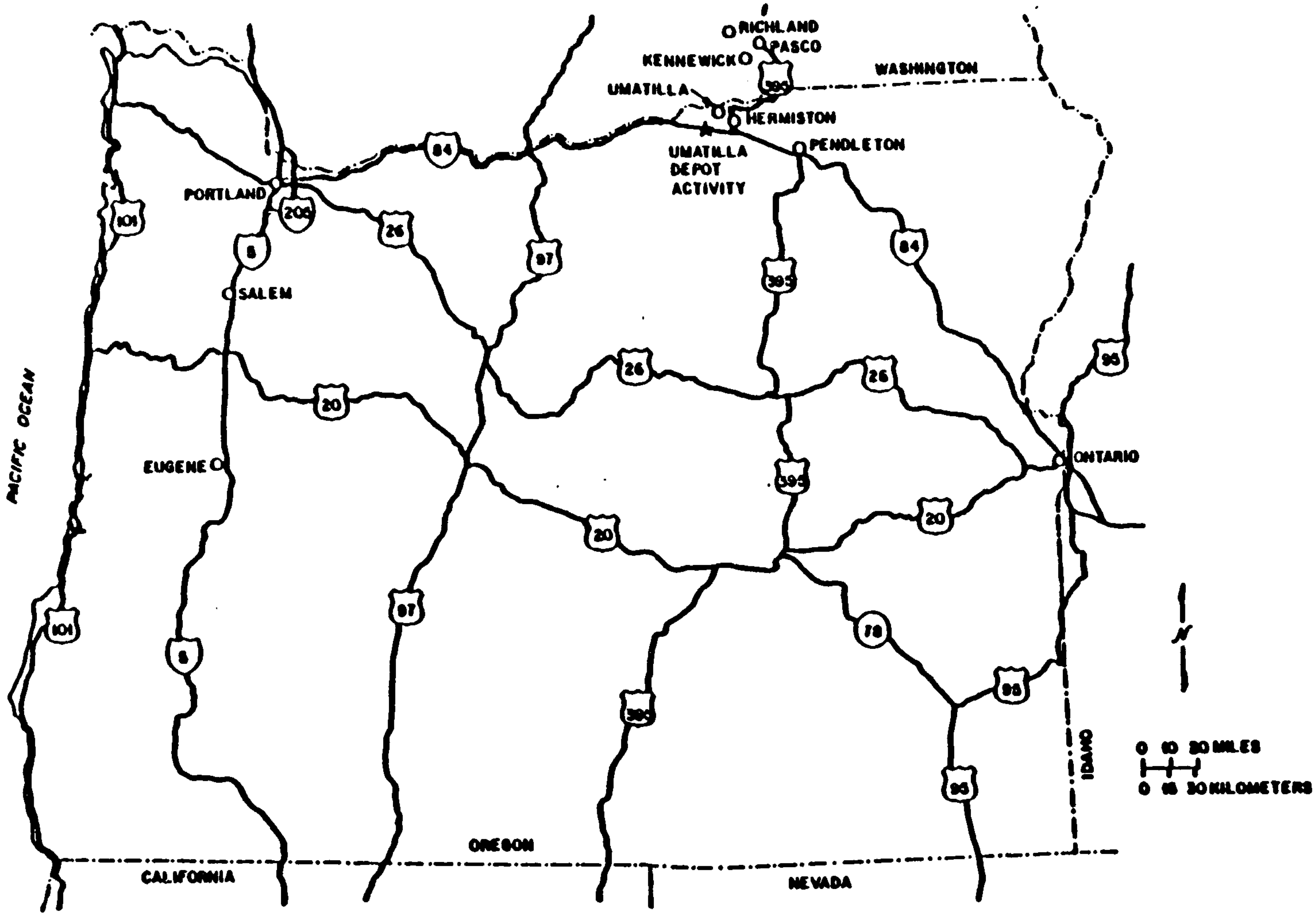

Fig. D-16. Oregon state map showing the location of UMDA

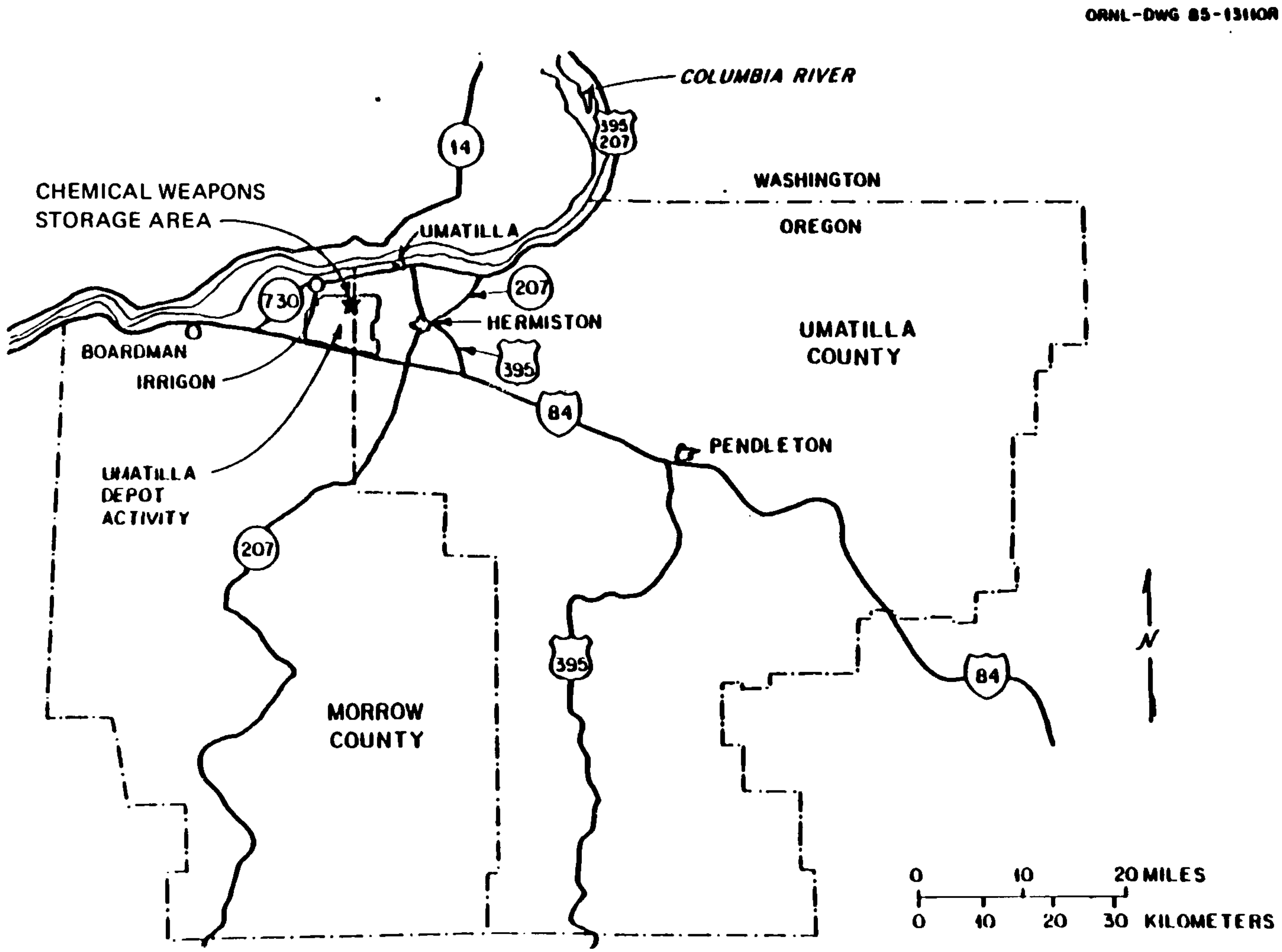

Fig. D-17. County map showing the location of UMDA

TABLE D-8
EARTHQUAKES IN THE VICINITY OF THE UMDA SITE[a]
(Chronological Listing)

Year	Month	Day	Location	Epicentral Intensity (MMI)
1893	3	5	Umatilla, OR	VI
1918	11	1	46.7N, 119.5W	V to VI
1921	9	14	Dixie, WA	V to VI
1924	1	6	Walla Walla, WA	IV
1924	1	6	Milton Weston, OR	V
1924	5	26	Walla Walla, WA	IV
1926	4	23	Walla Walla, WA	IV
1936	7	15	46.0N, 118.5W	VII
1936	7	18	46.0N, 118.3W	V
1936	7	20	Freewater, OR	IV
1936	8	4	45.8N, 118.6W	V
1936	11	17	Walla Walla, WA	III
1937	2	9	Walla Walla, WA	IV
1937	6	4	Walla Walla, WA	IV
1938	8	11	Milton, OR	IV
1938	10	27	Milton, OR	IV
1944	9	1	Walla Walla, OR	IV
1945	9	22	Walla, Walla, OR	IV
1951	1	7	McNary, OR	V
1959	1	20	Milton-Freewater, OR	V
1959	11	9	Heppner, OR	IV
1971	10	25	46.7N, 119.5W	IV

Earthquakes within a 50- to 60-mile radius of the Umatilla site, abstracted from Table 2.5-2, UNI-M-90, "N Reactor Updated Safety Analysis Report," United Nuclear Industries, Inc., February 28, 1978. Source: Ref. D-1.

The Medium Attack Tactical Electronic Warfare Wing bombing range is located 10 miles to the southwest of UMDA chemical munitions exclusion area. This area is a restricted airspace (Restriction numbers R-5701, R-5704, R-5706) in which the Navy holds bombing exercises. Grumman A-6 aircraft, in groups of four, fly about 14 sorties during the day and ten sorties at night, five days a week, dropping inert 25-lb bombs and, occasionally, 500- to 1000-lb inert bombs. Per the guidelines of Ref. D-8, this is not considered a significant threat. There are two low altitude federal airways in the general area of the depot: V-4 and V-112. Three high altitude airways (J-16, J-20, and J-54) cross within 6 miles of the depot toward Pendleton, Oregon.

The installation provides limited maintenance to preclude deterioration of facilities and retains limited shipping and receiving capabilities.

D.1.9. REFERENCES

D-1. Science Applications International Corporation, "Probabilities of Selected Hazards in Disposition of M55 Rockets," U.S. Army Toxic and Hazardous Materials Agency, M55-CS-2, November 1985.

D-2. Jeppesen, "United States High Altitude Enroute Charts," U.S. (HI) 1-5, March 1986.

D-3. "Aircraft Hazards," U.S. Nuclear Regulatory Commission Standard Review Plan 3.5.1.6, NUREG-0800, Rev 2, July 1981.

AD-A193 354 CHEMICAL STOCKPILE DISPOSAL PROGRAM RISK ANALYSIS OF THE ONSITE DISPOSAL O..(U) GA TECHNOLOGIES INC SAN DIEGO CA A W BARSELL ET AL. AUG 87 GA-C-18562 8/9

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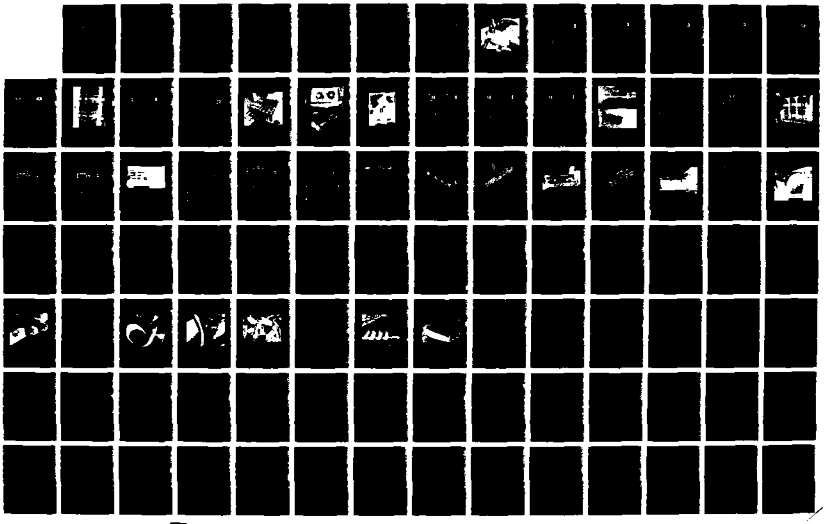

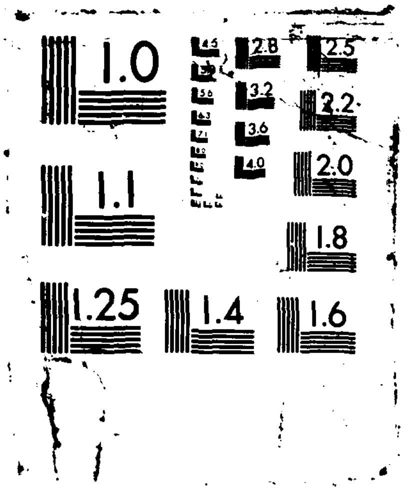
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2.8
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4.0
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1.1
1.8
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1.6

APPENDIX E
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APPENDIX F
MUNITION FAILURE THRESHOLDS

F.1. MUNITION FAILURE THRESHOLDS

The munition stockpile is comprised of 11 different munition types. This appendix contains a description of the physical characteristics of each munition type, a description of their existing storage configurations, and a description of the munition failure thresholds that are important for quantifying the agent release associated with each accident scenario. The failure thresholds discussed herein are the thresholds for accidental burster detonation, the thermal threshold for hydraulic rupture of the agent compartment, and the mechanical failure thresholds which lead to failure of the agent compartment.

F.1.1. DESCRIPTION OF CHEMICAL MUNITIONS

The chemical stockpile is presently made up of the following munitions:

1. 8-in. artillery projectiles. The 8-in. projectiles are filled with the nerve, agent either GB or VX. They are stored without fuzes, but they may be stored with or without bursters. The 8-in. projectiles are stored on wooden pallets with six rounds per pallet.

2. 155-mm artillery projectiles. The 155-mm projectiles may contain GB, VX, or mustard. They are stored without fuzes, but they may be with or without bursters. The 155-mm projectiles are stored on wooden pallets with eight rounds per pallet.

3. 105-mm artillery rounds. The rounds are filled with either mustard or GB. The rounds may be stored as bare projectiles

on wooden pallets, with 24 rounds per pallet, and with 2 pallets butted together and secured with steel banding, or as cartridges in fiber tubes, with two tubes in a wooden field box, and with either 12 or 15 boxes unitized on a skid based wooden pallet. The cartridges include burster, fuze, cartridge case and propellant.

4. 4.2-in. mortar projectiles. All are filled with mustard agent. The mortars may be stored with burster, fuze, and propellant in fiber tubes, with two tubes in a wooden field box, with either 36 boxes on a wooden pallet, or 24 boxes on a wooden skid base. The mortars may also be stored without burster and fuze in wooden pallets.

5. M23 land mines. All land mines are filled with VX. The mines are burstered, and are packaged three to a steel drum. Mine activators and fuzes are packaged separately in the same drum. Twelve drums are contained on a wooden pallet.

6. M55 rockets. The M55 rockets are filled with either GB or VX. The rockets are equipped with fuzes and bursters which contain explosives. Propellant is also built into the motor of the rocket. The rocket casing is made of aluminum which may slowly react with nerve agent to form hydrogen gas. Pressure buildup in some of the rockets has caused a leakage problem.

   The rockets are individually packaged in fiberglass shipping tubes with metal end caps. Fifteen containers with rockets are packed on a wooden pallet.

7. MC-1 750-lb bombs filled with GB. The MC-1 bombs are stored without explosive components on wooden pallets with two bombs per pallet.

8. MK-94 500-lb bombs filled with GB. The MK-94 bombs are stored without explosive components in individual MK-410 storage and shipping containers.

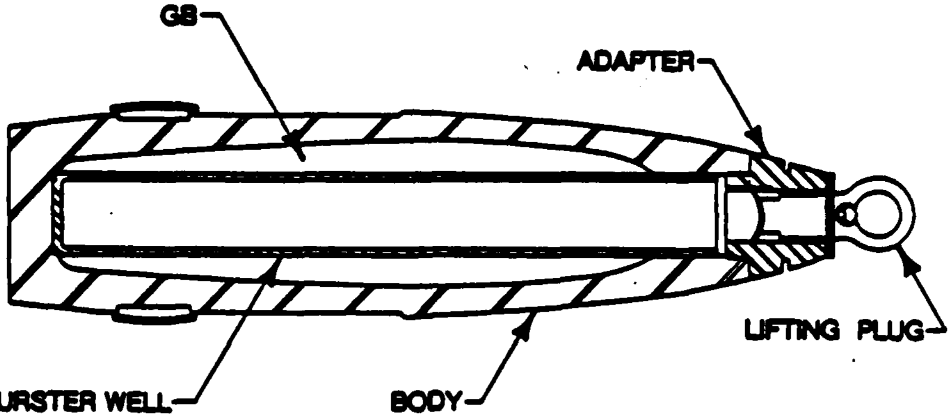
9. MK-116 (Weteye) 600-lb Navy bombs filled with GB. These bombs are stored without explosive components in individual MK-398 storage and shipping containers.

10. TMU-28/B airborne spray tanks filled with VX. They were designed for releasing chemical agent from slow-traveling, low-flying aircraft. The spray tanks are stored in individual CNU-77/E23 storage and shipping containers.

11. Ton containers. A large fraction of the chemical stockpile is stored in bulk form in cylindrical steel containers referred to as ton containers. The ton containers may contain GB, VX, or mustard. The ton containers are not palletized, but are banded together in clusters.

Drawings and photographs of each of the above munitions are shown in Figs. F-1 through F-35.

During transportation of the munitions, either to an onsite disposal facility or an offsite disposal facility, the munitions are placed in a protective shipping container or package. The shipping package has not yet been designed, but criteria for the structural and thermal protection to be provided during munition transport are defined in Ref. F-1.



LENGTH	35.1 in.
DIAMETER	8 in.
TOTAL WT.	199 lb.
AGENT	GB
AGENT WT.	14.5 lb.
FUZE	None
BURSTER	M83
EXPLOSIVE	Comp B
EXPLOSIVE WT.	7.0 lb.
SUPP. CHARGE	0.3 lb. TNT
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	6 rounds/wooden pallet

PROJECTILE, 8 INCH, GB, M426

Fig. F-1. Projectile, 8-in., GB, M426

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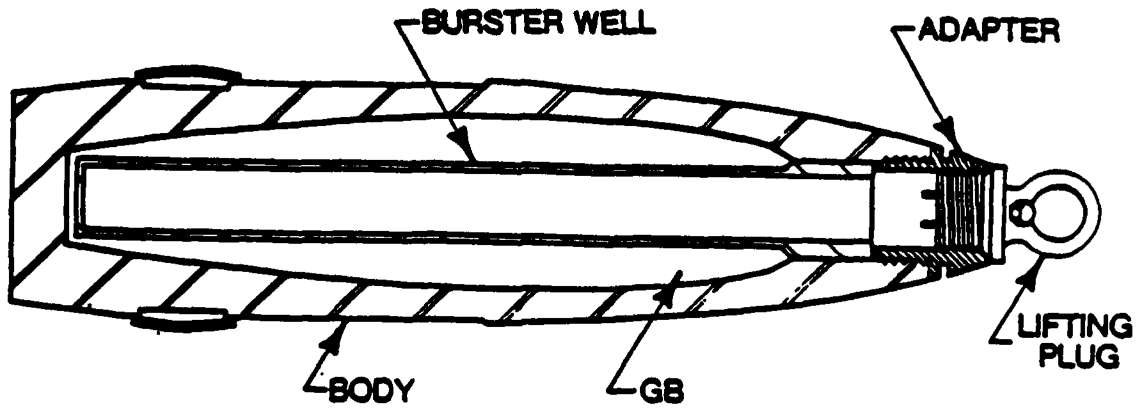
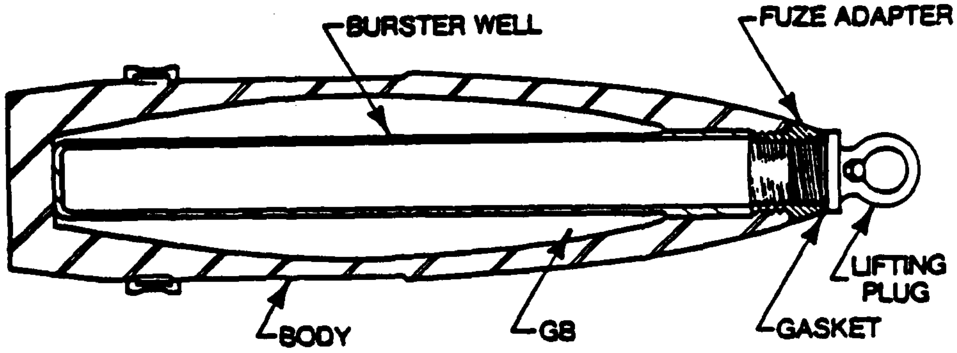
Fig. F-2. Eight-inch projectiles are stored on wooden pallets, six rounds to a pallet



LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	M37
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	2.75 lb.
SUPP. CHARGE	0.3 lb. Tetrytol
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

PROJECTILE, 155mm, GB, M121

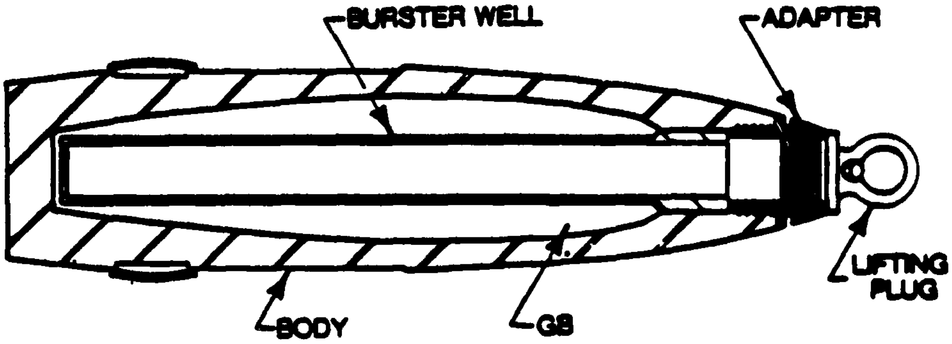
Fig. F-3. Projectile, 155-mm, GB, M121



LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	M71
EXPLOSIVE	Comp B4
EXPLOSIVE WT.	2.45 lb.
SUPP. CHARGE	0.3 lb. Tetrytol
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

PROJECTILE, 155mm, GB, M121A1

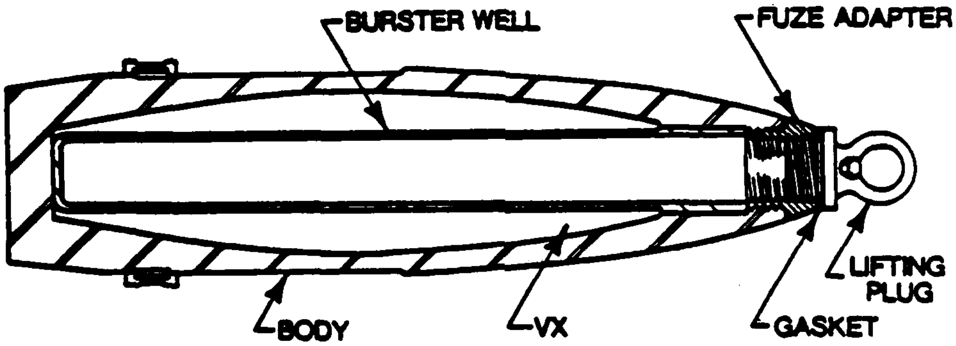
Fig. F-4. Projectile, 155-mm, GB, M121A1



LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	GB
AGENT WT.	6.5 lb.
FUZE	None
BURSTER	M37
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	2.75 lb.
SUPP. CHARGE	0.3 lb. TNT
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

PROJECTILE, 155mm, GB, M122

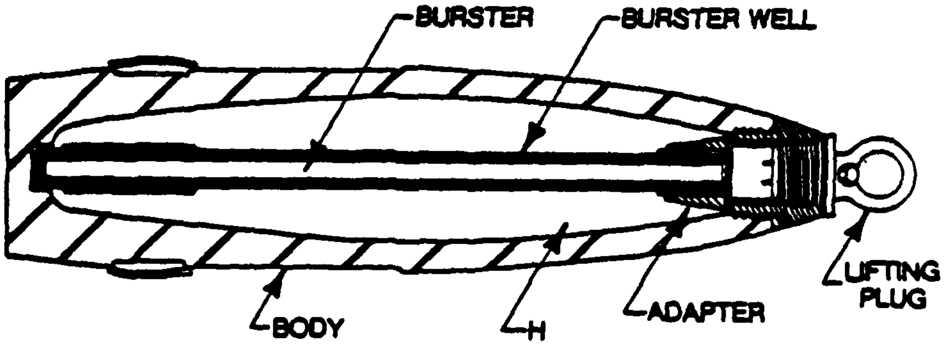
Fig. F-5. Projectile, 155-mm, GB, M122



LENGTH	26.7 in.
DIAMETER	155mm
TOTAL WT.	100 lb.
AGENT	VX
AGENT WT.	6.0 lb.
FUZE	None
BURSTER	M71
EXPLOSIVE	Comp B4
EXPLOSIVE WT.	2.45 lb.
SUPP. CHARGE	0.3 lb. Tetrytol
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	8 rounds/wooden pallet

PROJECTILE, 155mm, VX, M121A1

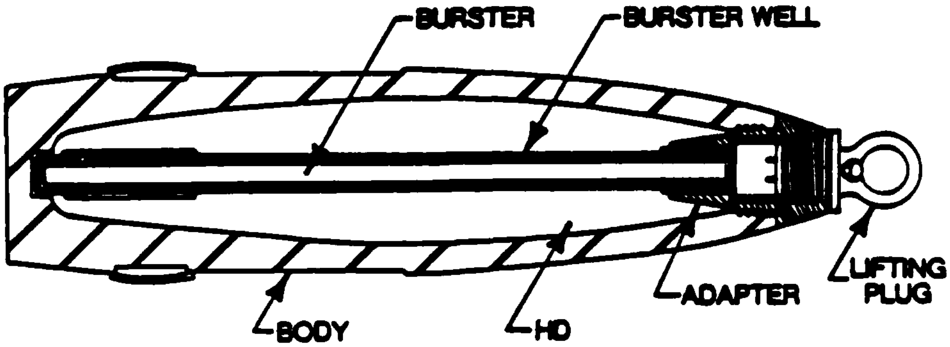
Fig. F-6. Projectile, 155-mm, VX, M121A1



LENGTH	26.8 in.
DIAMETER	155mm
TOTAL WT.	99 lb.
AGENT	H
AGENT WT.	11.7 lb.
FUZE	None
BURSTER	M6
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	.41 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	5A
PACKAGING	6 rounds/wooden pallet

PROJECTILE, 155mm, H, M110

Fig. F-7. Projectile, 155-mm, H, M110



LENGTH	26.8 in.
DIAMETER	155mm
TOTAL WT.	95 lb.
AGENT	HD
AGENT WT.	11.7 lb.
FUZE	None
BURSTER	M6
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	.41 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	5A
PACKAGING	6 rounds/wooden pallet

PROJECTILE, 155mm, HD, M104

Fig. F-8. Projectile, 155-mm, HD, M104

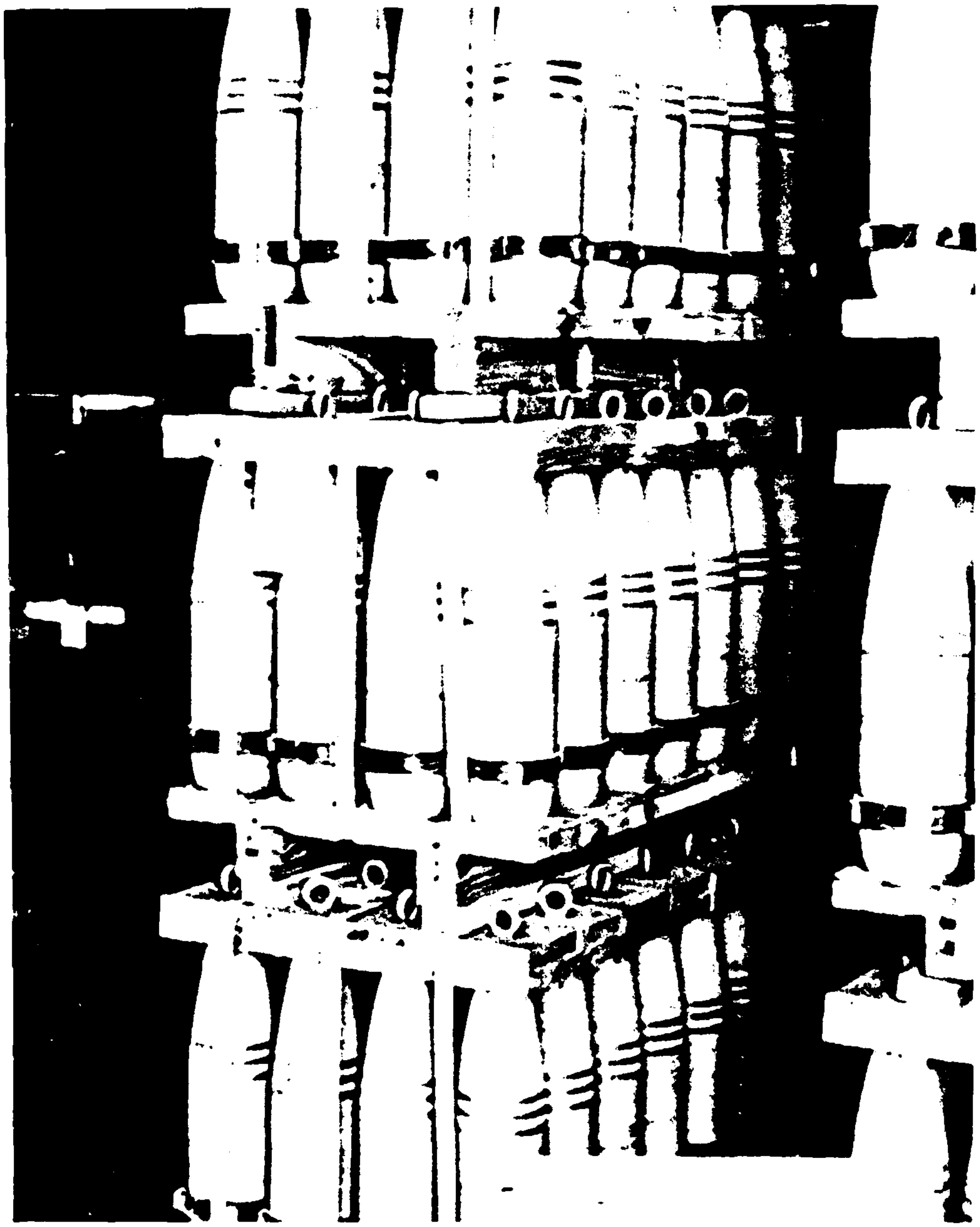


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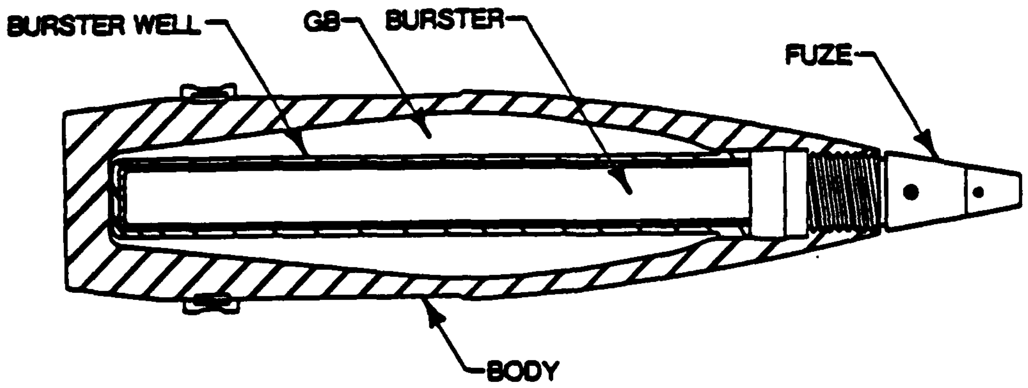
Fig. F-9. 155-mm projectiles are stored on wooden pallets with eight rounds per pallet

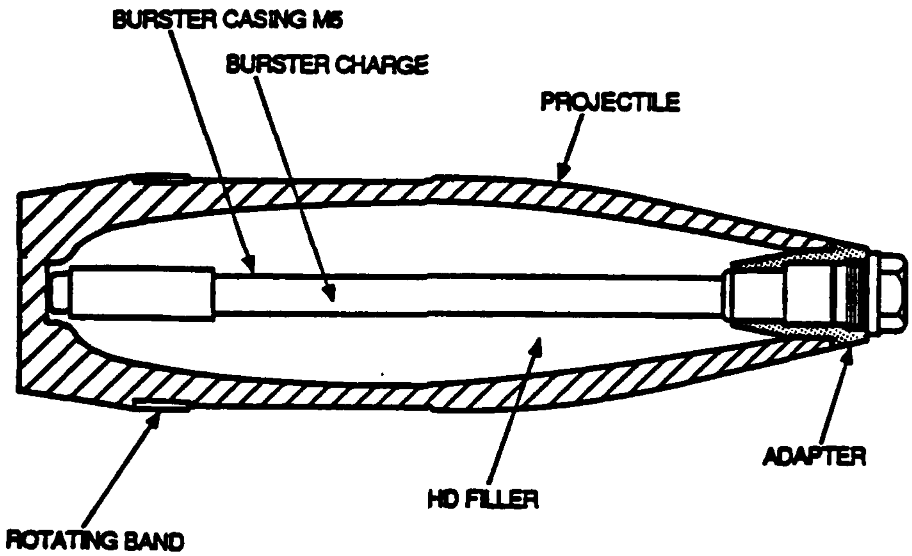


LENGTH	16.0 in.
DIAMETER	105mm
TOTAL WT.	32 lb.
AGENT	GB
AGENT WT.	1.63 lb.
FUZE	M508
BURSTER	M40, M40A1
EXPLOSIVE	Tetrytol(M-40) Comp B(M40A)
EXPLOSIVE WT.	1.12 lb.
PROPELLANT	Removed
QD/SCG	5A
PACKAGING	24 projectiles/wooden pallet

Note: Projectile is stored with and without fuze and burster. Fuze cavity of unfuzed unburstered projectile is sealed by a closing plug.

PROJECTILE, 105mm, GB, M360

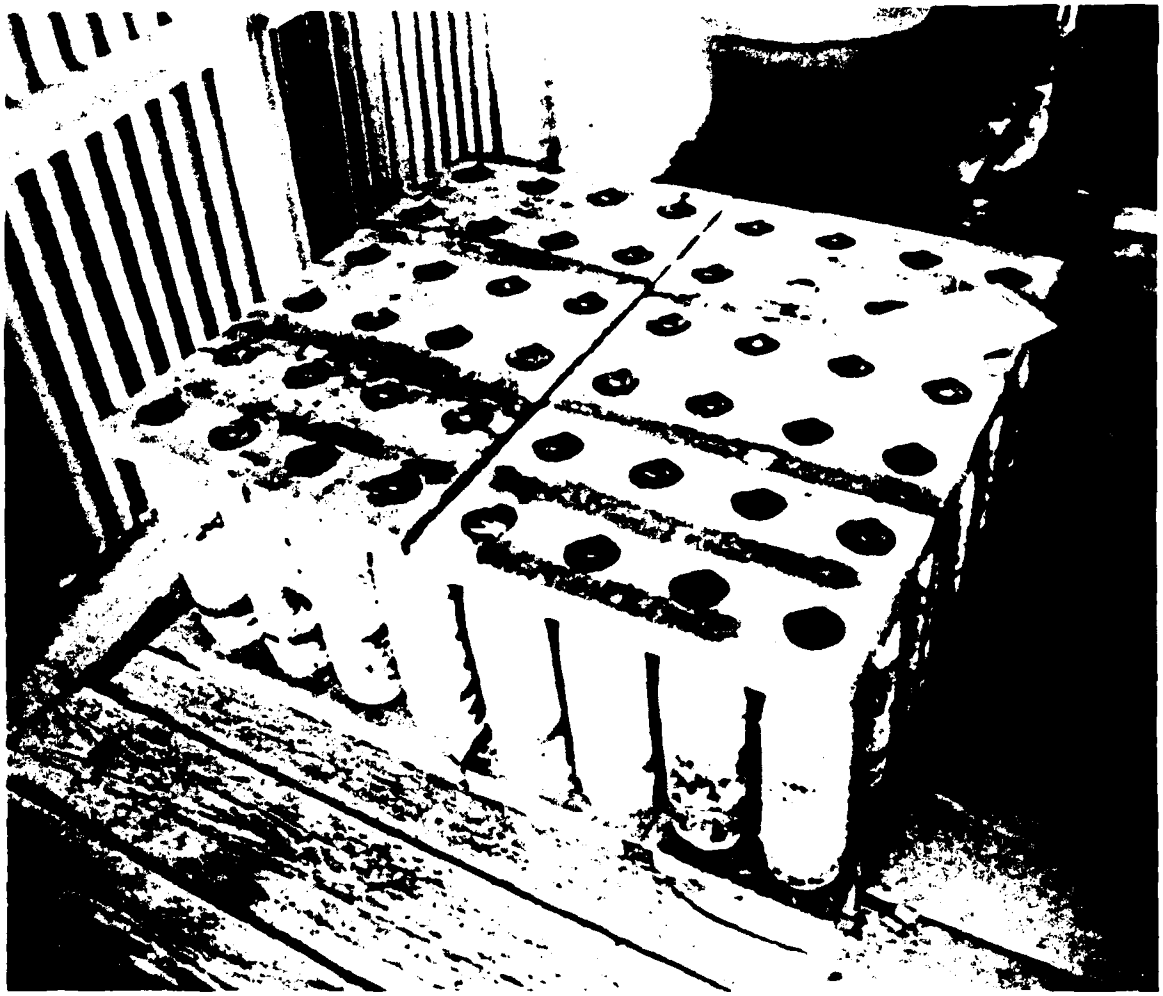
Fig. F-10. Projectile, 105-mm, GB, M360



LENGTH	21.0 in.
DIAMETER	105mm
TOTAL WT.	32 lb.
AGENT	HD
AGENT WT.	3 lb.
FUZE	PD M51A5, M57
BURSTER	M5
EXPLOSIVE	Tetrytol
EXPLOSIVE WT.	0.51 lb.
PROPELLANT	Removed
PACKAGING	24 projectiles/wooden pallet

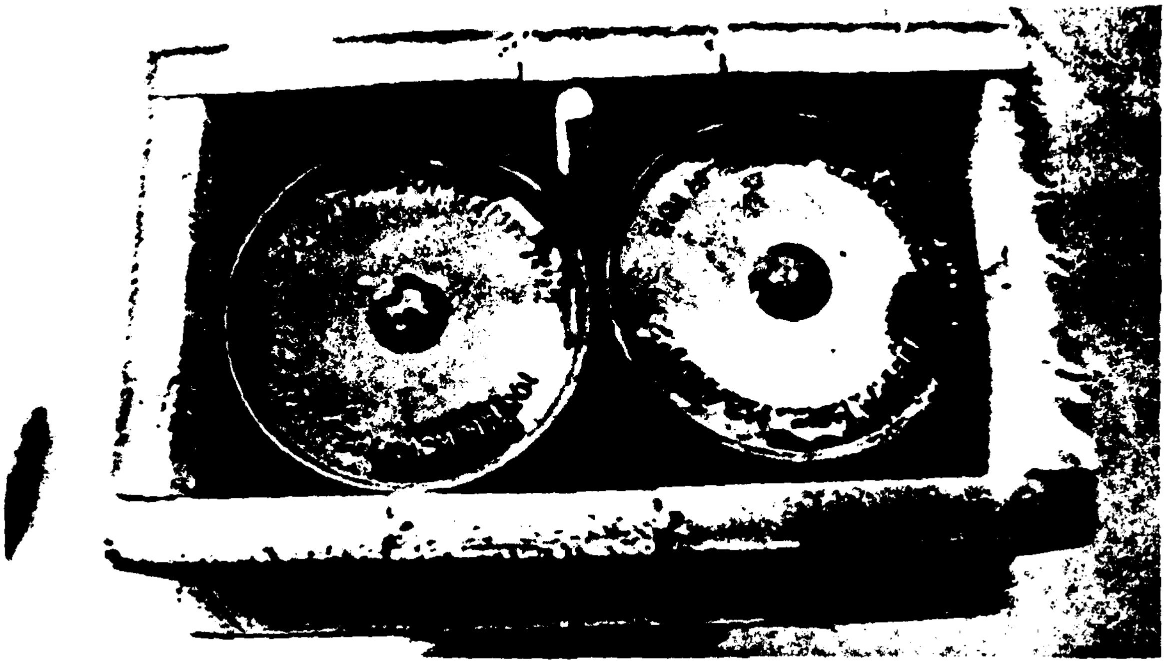
PROJECTILE, 105mm, HD, M60

Fig. F-11. Projectile, 105-mm, HD, M60

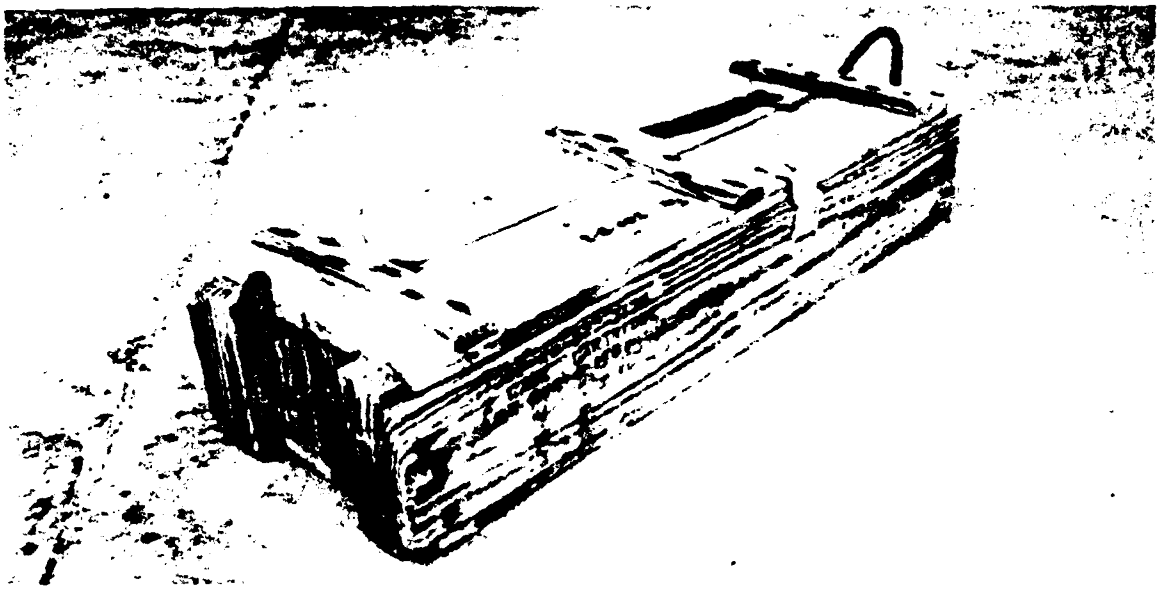


830125-21

Fig. F-12. 105-mm artillery rounds stored in one of the two acceptable configurations



840163-24

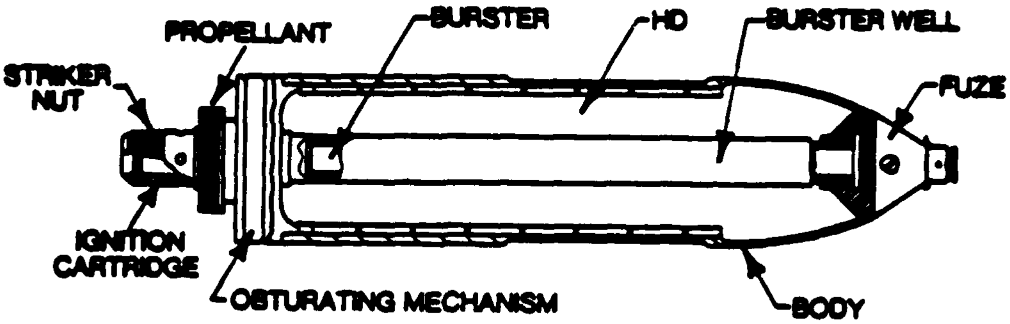


840163-15

Fig. F-13. 105-mm artillery rounds stored in cartridges in fiber tubes with two tubes to a wooden box

840099-43

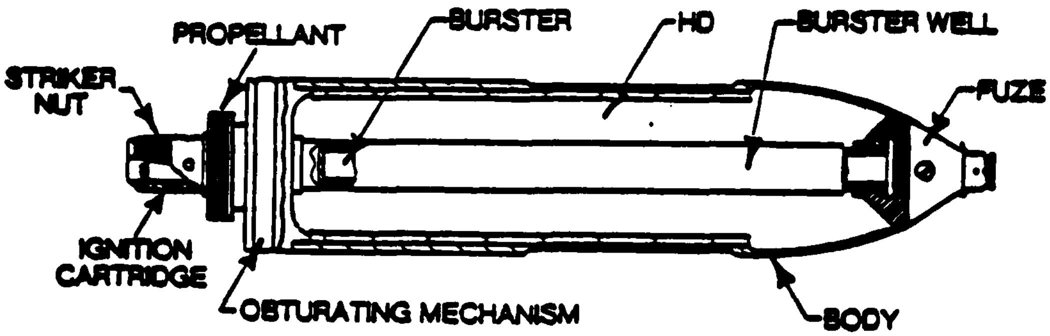
Fig. F-14. MC-1 bombs are stored on wooden pallets



LENGTH	21.0 in.
DIAMETER	4.2 in.
TOTAL WT.	25 lb.
AGENT	HD
AGENT WT.	6.0
FUZE	M8
BURSTER	M14
EXPLOSIVE	Tetryl
EXPLOSIVE WT.	.14 lb.
PROPELLANT	Removed
PRIMER	M28A2
QD/SCG	5A
PACKAGING	24 rounds/wooden pallet

CARTRIDGE, MORTAR, 4.2 INCH, HD, M2/M2A1

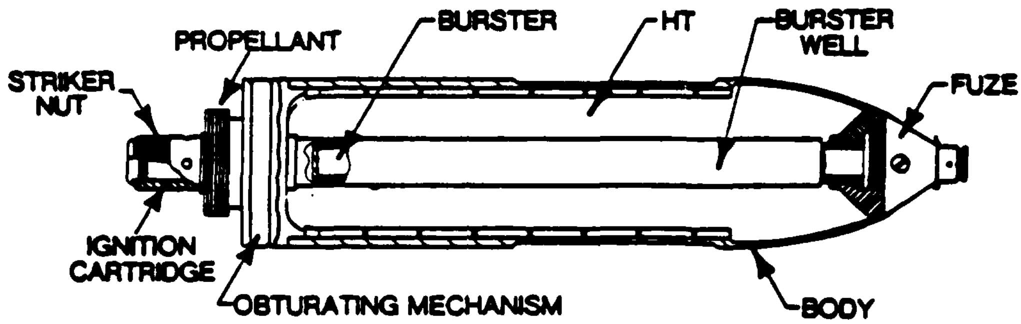
Fig. F-15. Cartridge, mortar, 4.2-in., HD, M2/M2A1



LENGTH	21.0 in.
DIAMETER	4.2 in.
TOTAL WT.	25 lb.
AGENT	HD
AGENT WT.	6.0
FUZE	M8
BURSTER	M14
EXPLOSIVE	Tetryl
EXPLOSIVE WT.	.14 lb.
PROPELLANT	Removed
PRIMER	M28A2
QD/SCG	5A
PACKAGING	24 rounds/wooden pallet

CARTRIDGE, MORTAR, 4.2 INCH, HD, M2/M2A1

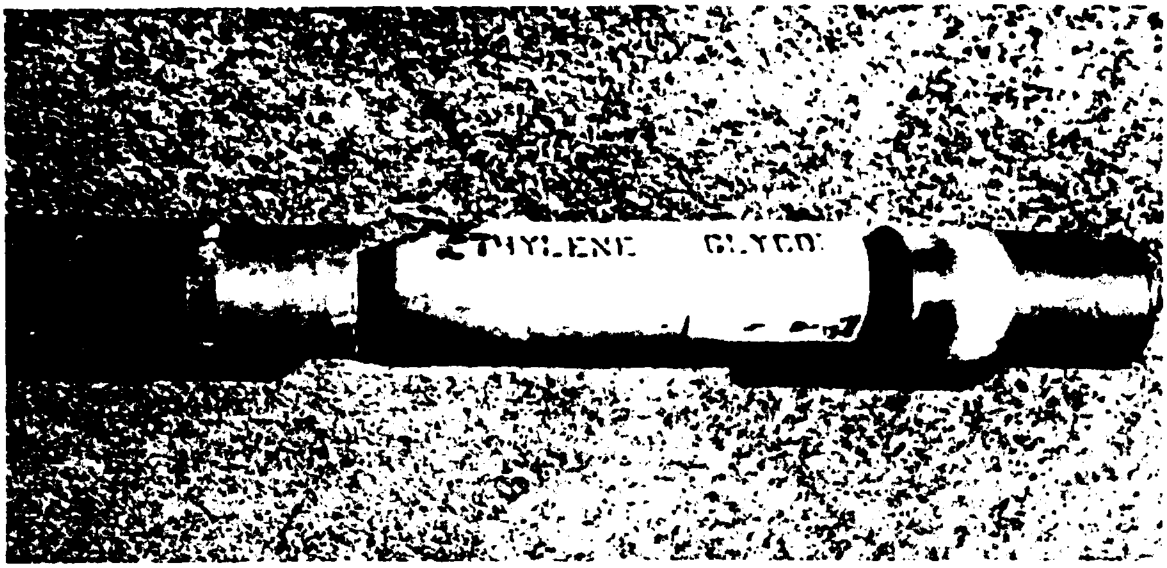
Fig. F-16. Cartridge, mortar, 4.2-in., HD, M2/M2A1



LENGTH	21.0 in.
DIAMETER	4.2 in.
TOTAL WT.	25 lb.
AGENT	HT
AGENT WT.	5.8 lb.
FUZE	M51A5
BURSTER	M14
EXPLOSIVE	Tetryl
EXPLOSIVE WT.	.14 lb.
PROPELLANT	Removed
PRIMER	M28A2
QD/SCG	5A
PACKAGING	24 rounds/wooden pallet

CARTRIDGE, MORTAR, 4.2 INCH, HT, M2/M2A1

Fig. F-17. Cartridge, mortar, 4.2-in., HT, M2/M2A1



830125-7

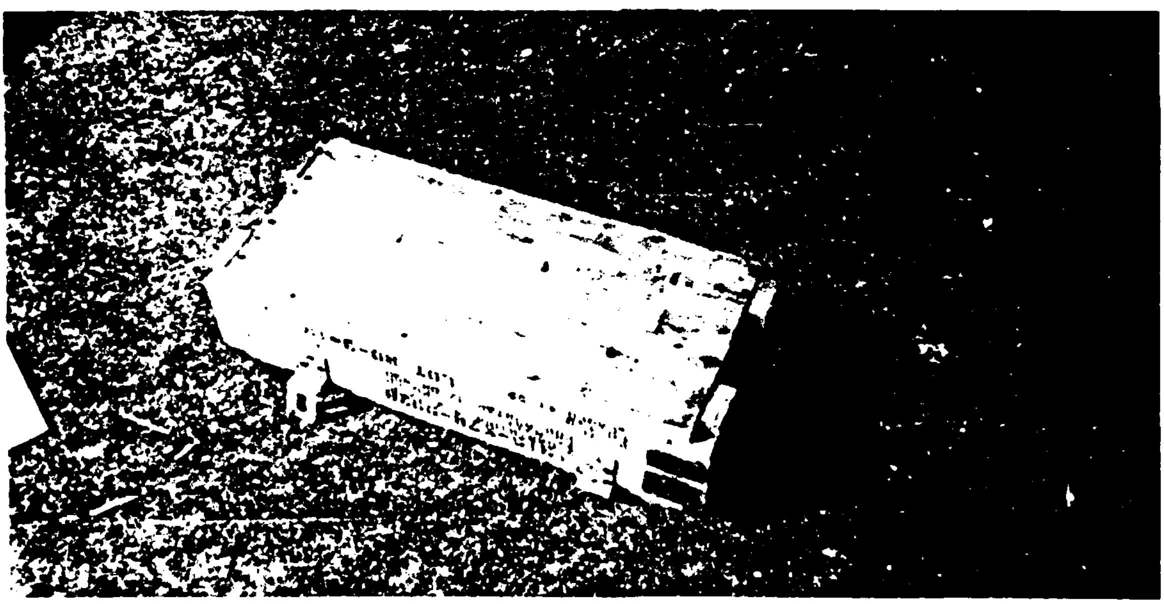


Fig. F-18. 4.2-in. mortars are stored in fiber tubes with two tubes per wooden box

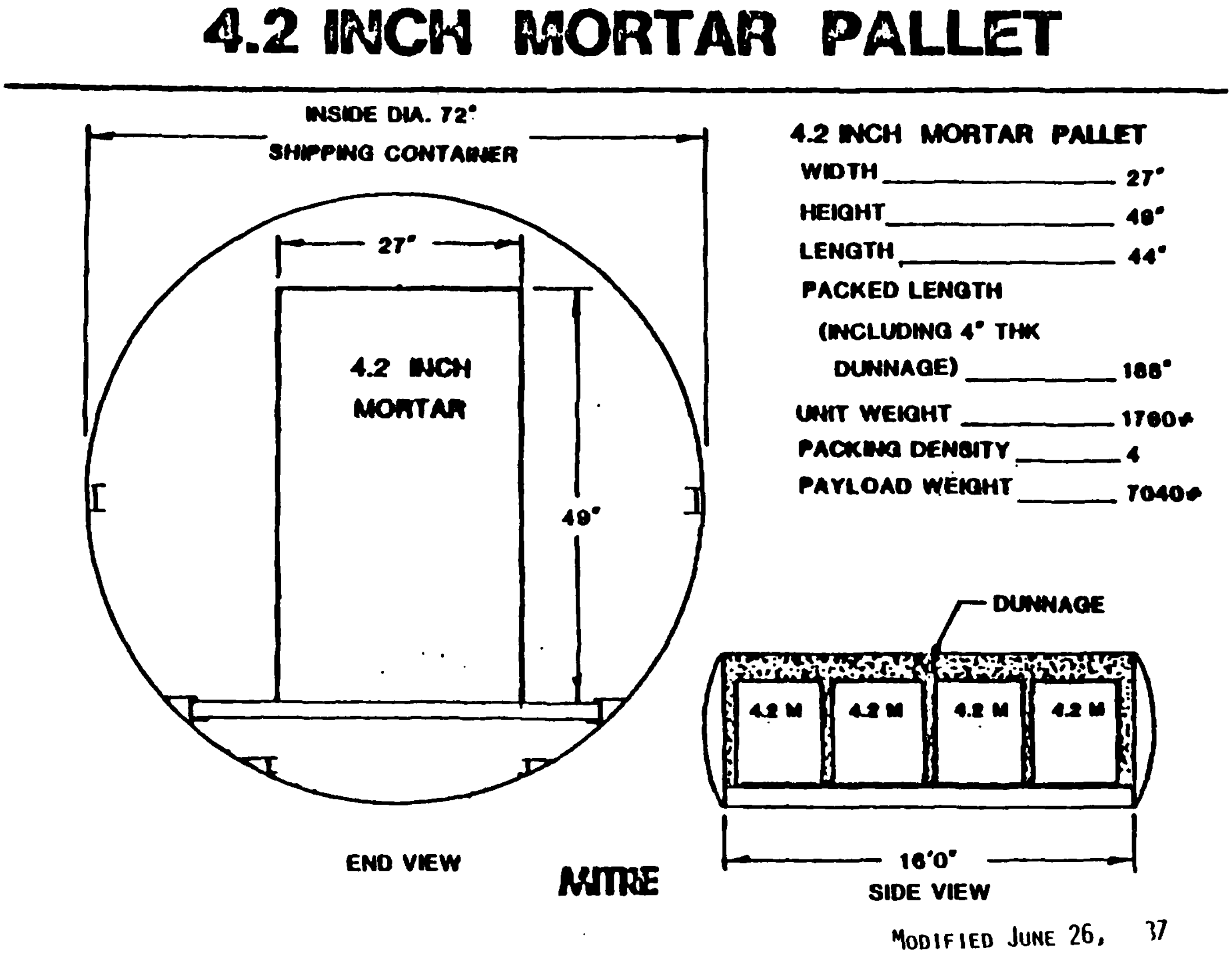
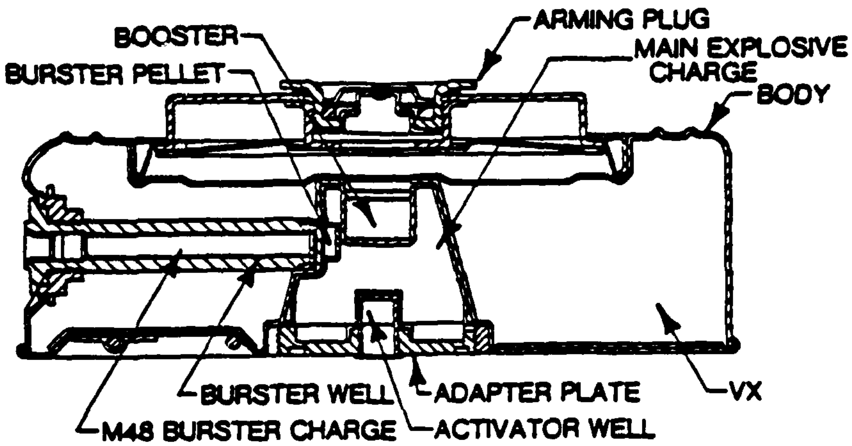


Fig. F-19. 4.2-in. mortar round pallet containing 48 rounds packed two per box



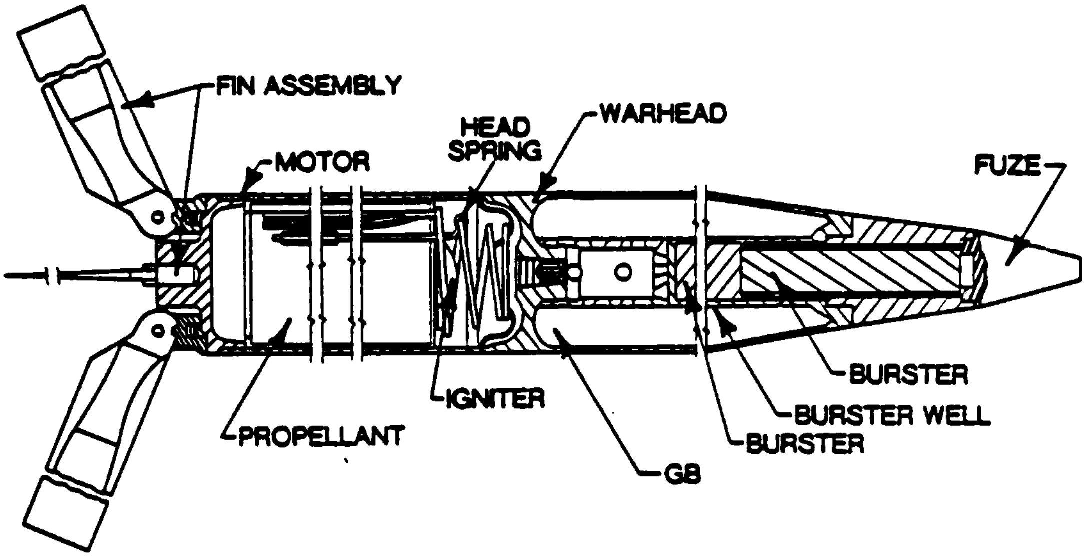
HEIGHT	5 in.
DIAMETER	13.5 in.
TOTAL WT.	23 lb.
AGENT	VX
AGENT WT.	10.5 lb.
FUZE	M603
BURSTER	M38
EXPLOSIVE	Comp B
EXPLOSIVE WT.	.8 lb.
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	N/A
QD/SCG	5A
PACKAGING	3 mines/steel drum

MINE, 2 GALLON, VX, M23

Fig. F-20. Mine, 2-gal, VX, M23

830125-3

Fig. F-21. M23 mines are stored in drums with three mines per drum

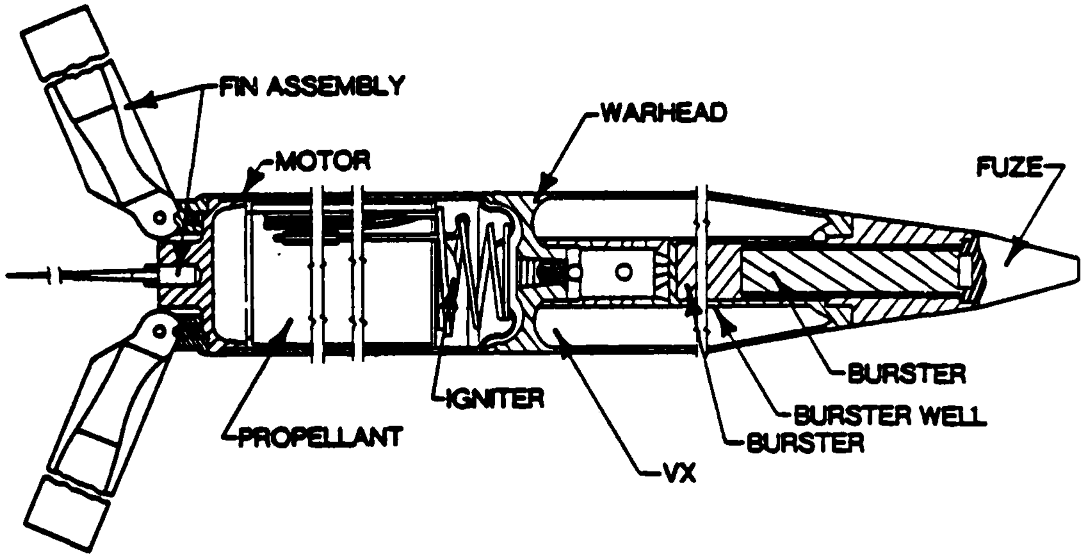


LENGTH	78.0 in.
DIAMETER	115mm
TOTAL WT.	57 lb.
AGENT	GB
AGENT WT.	10.7 lb.
FUZE	M417
BURSTER	M34, M36
EXPLOSIVE	Comp B
EXPLOSIVE WT.	3.2 lb.
PROPELLANT	M28
PROPELLANT WT.	19.3
PRIMER	M62
QD/SCG	5A
PACKAGING	15 rounds/wooden pallet

Note: Stored in firing tube with fins folded toward the axis.

ROCKET, 115mm, GB, M55

Fig. F-22. Rocket, 115-mm, GB, M55



LENGTH	78 in.
DIAMETER	115mm
TOTAL WT.	56 lb.
AGENT	VX
AGENT WT.	10.0 lb.
FUZE	M417
BURSTER	M34, M36
EXPLOSIVE	Comp B
EXPLOSIVE WT.	3.2 lb.
PROPELLANT	M67
PROPELLANT WT.	19.3 lb.
PRIMER	M62
QD/SCG	5A
PACKAGING	15 round/wooden pallet

Note: Stored in firing tube with fins folded toward the axis.

ROCKET, 115mm, VX, M55

Fig. F-23. Rocket, 115-mm, VX, M55

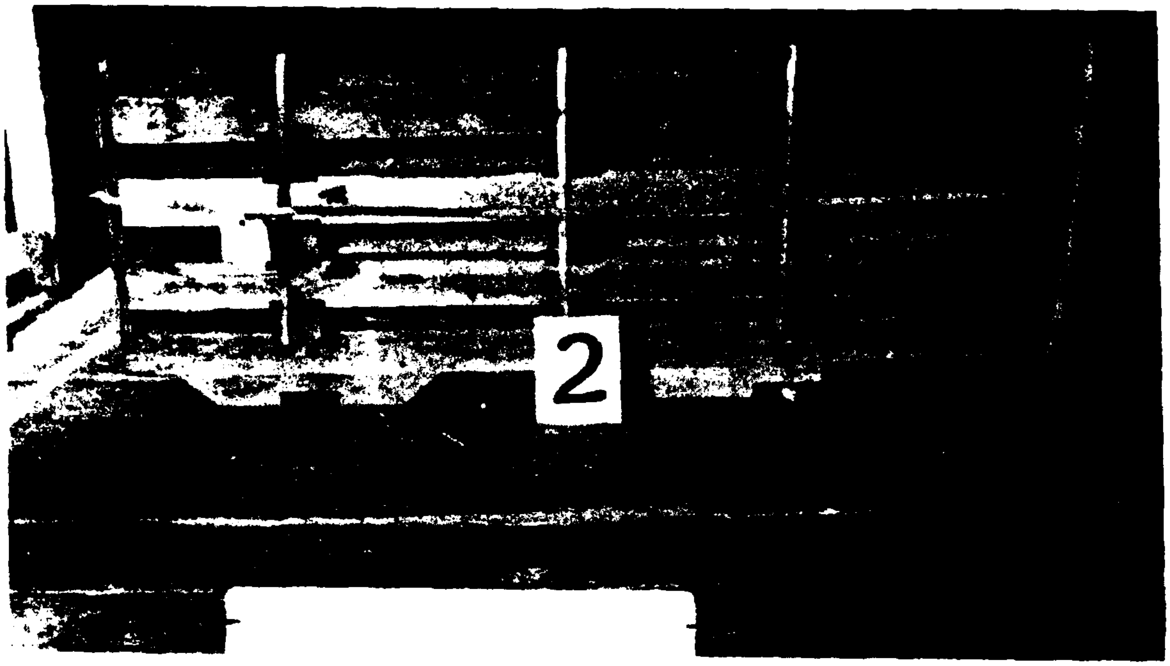
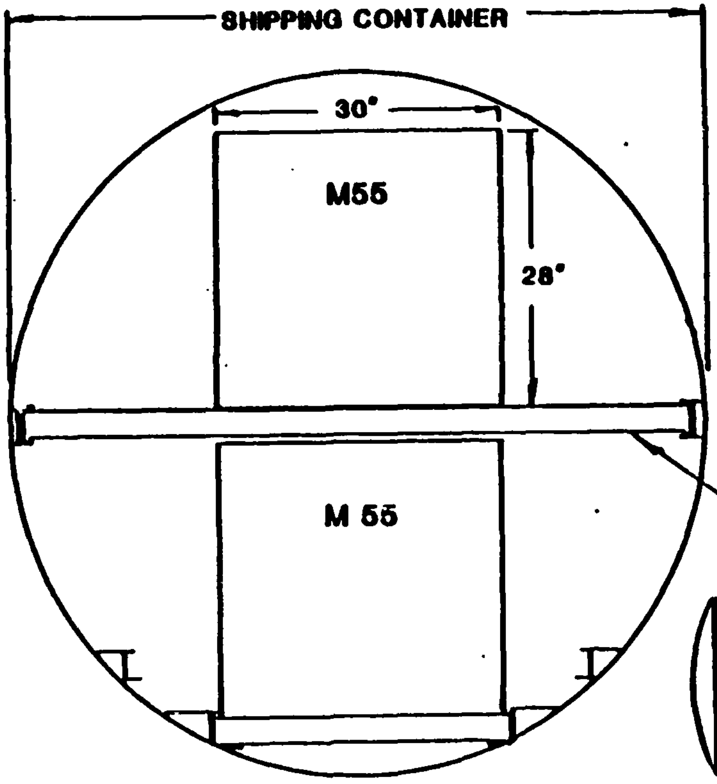


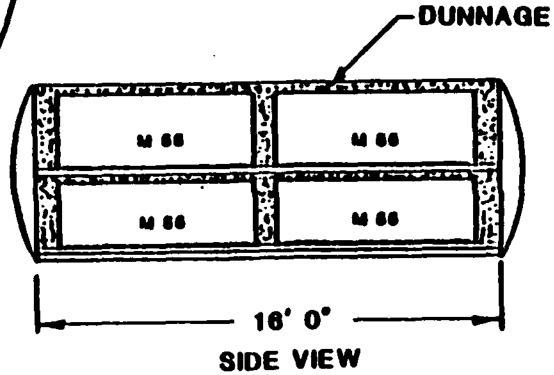
Fig. F-24. M55 rockets are stored in their shipping tubes with 15 rockets housed in a wooden crate

M 55 ROCKET PALLET



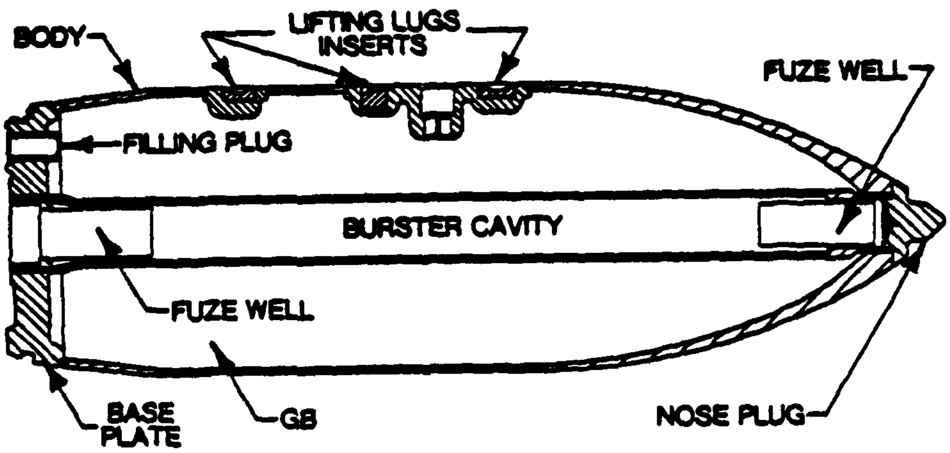
M 55 ROCKET PALLET

WIDTH	30"
HEIGHT	28"
LENGTH	83"
PACKED LENGTH (INCLUDING 8.6" THK. DUNNAGE)	14' 6"
UNIT WEIGHT	1350#
PACKING DENSITY	4
PAYLOAD WEIGHT	5400#



MITRE

Fig. F-25. 115-mm M55 rocket pallet containing 15 rockets in individual fiberglass tubes (15/pallet)



LENGTH	50 in.
DIAMETER	16 in.
TOTAL WT.	725 lb.
AGENT	GB
AGENT WT.	220 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	2 bombs/wooden pallet

BOMB, 750 LB., GB, MC-1

Fig. F-26. Bomb, 750-lb, GB, MC-1

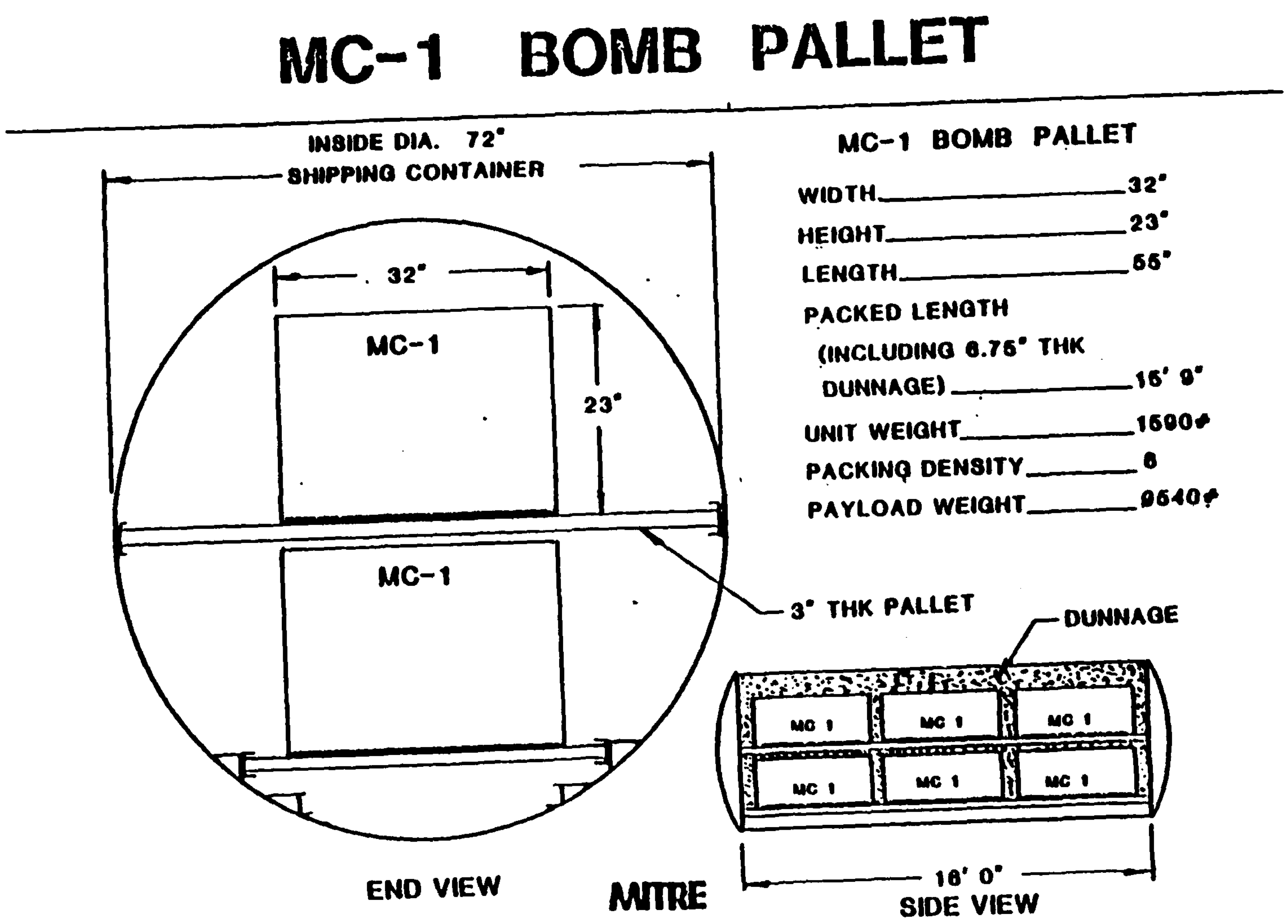
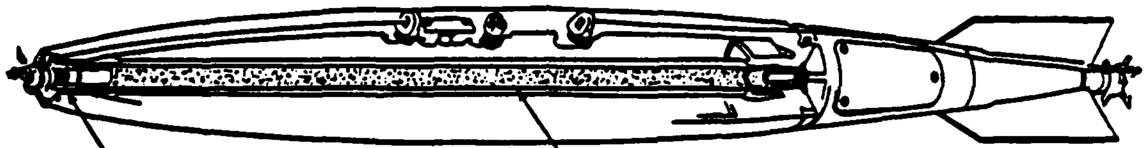


Fig. F-27. MC-1 750-lb bomb pallet with two bombs



LENGTH	89 in.
DIAMETER	11 in.
TOTAL WT.	441 lb.
AGENT	GB
AGENT WT.	108
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PRIMER	None
PACKAGING	1 bomb/pallet

Fig. F-28. Bomb, 500-lb, GB, MK 94-0

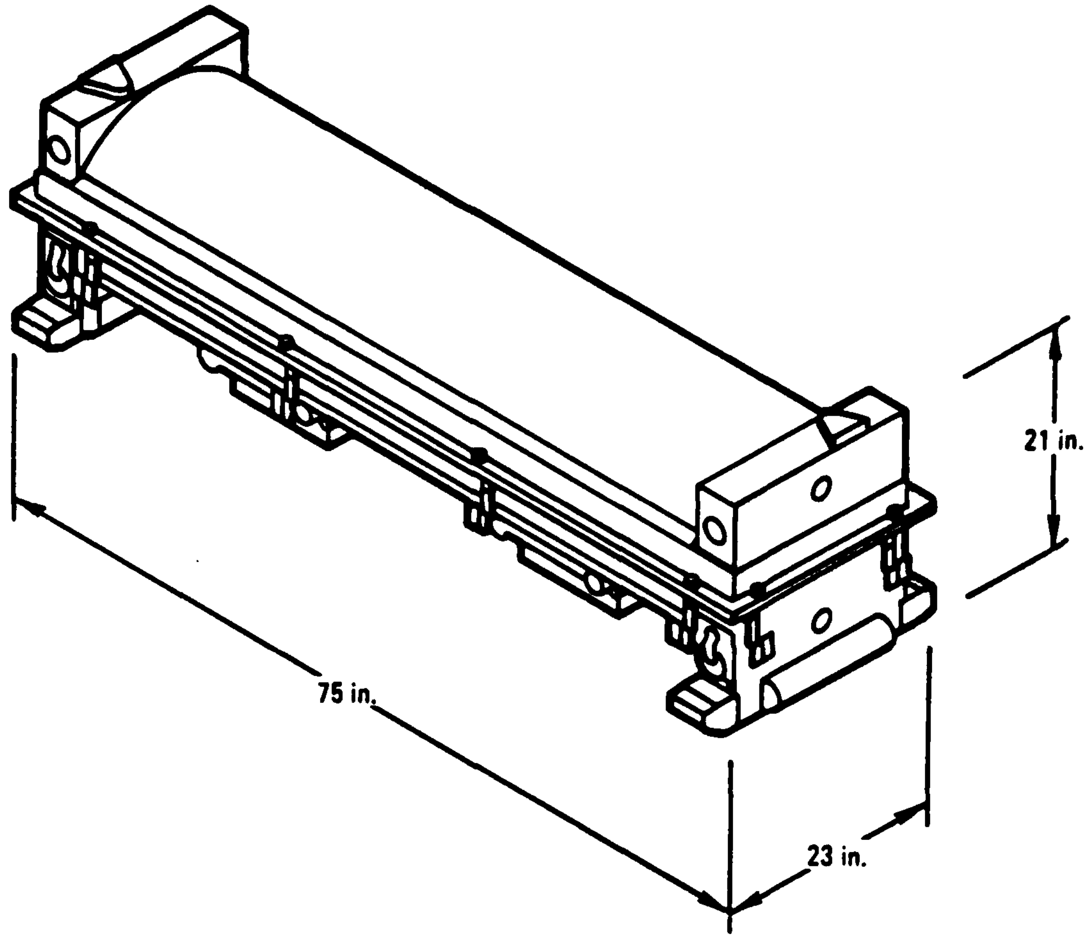
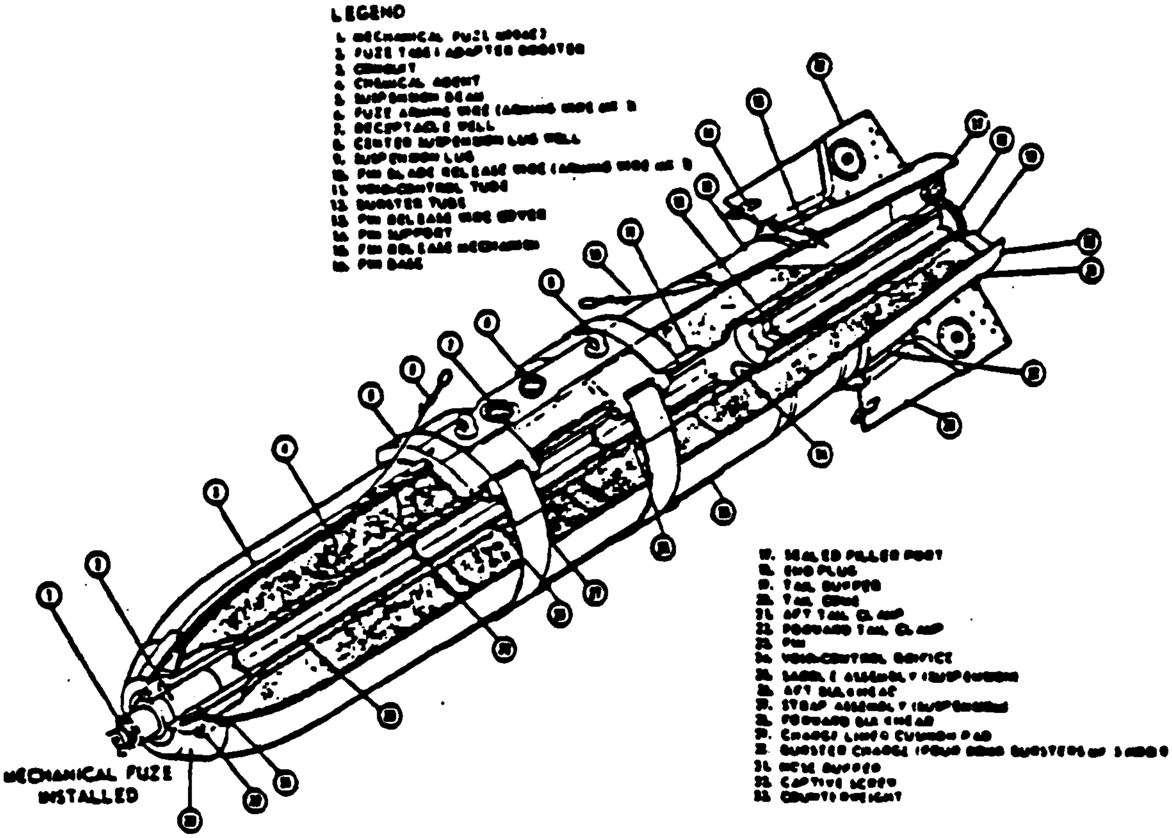


Fig. F-29. MK-94 bombs are stored individually in MK-410 storage and shipping containers



LENGTH	86 in.
DIAMETER	14 in.
TOTAL WT.	525 lb.
AGENT	GB
AGENT WT.	384 lb.
FUZE	M904E2
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PRIMER	None
PACKAGING	Stored in a metal shipping and storage container

Fig. F-30. MK-116 Mod 0 bomb (Weteye) with M990 D fuze installed

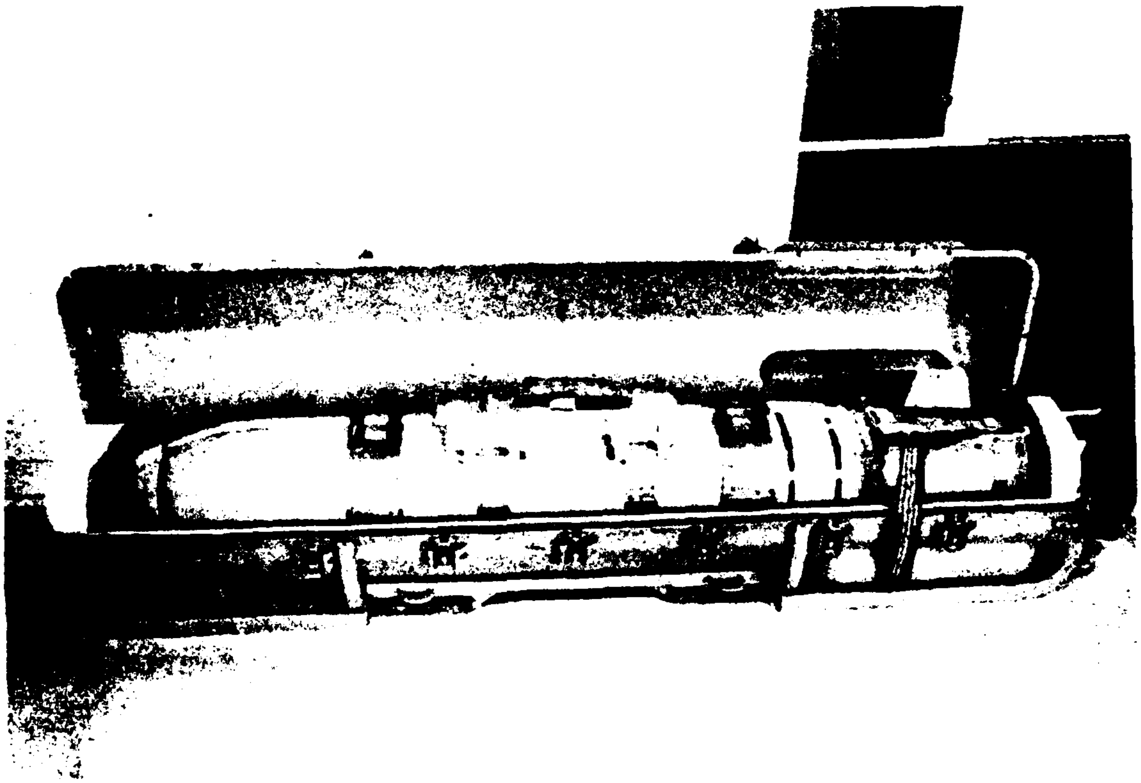
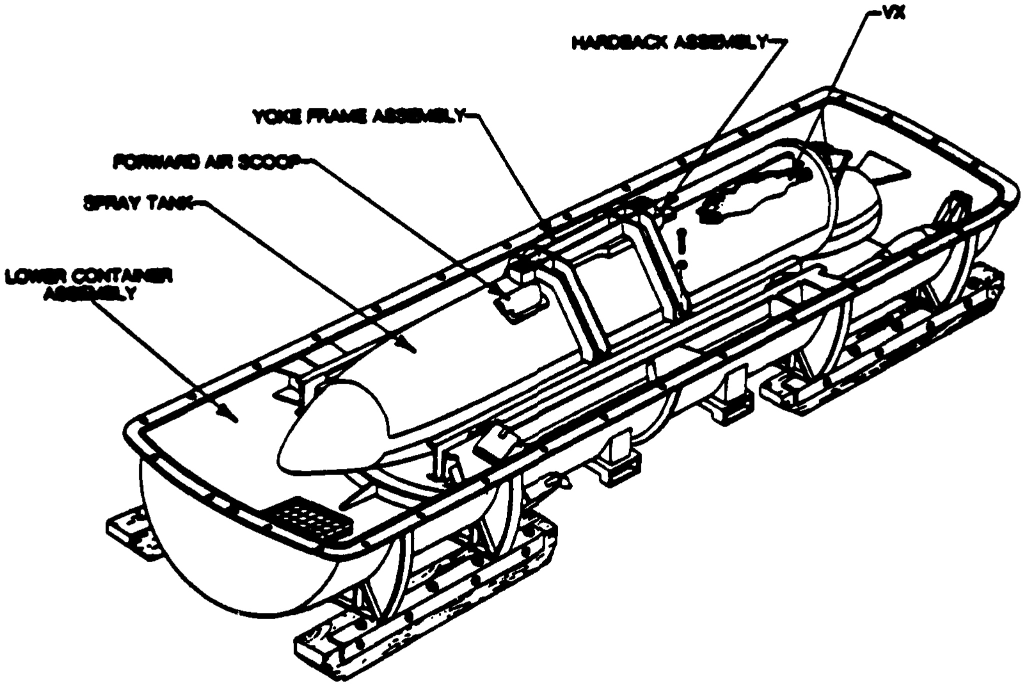


Fig. F-31. MK-116 bombs are stored individually in MK-398 storage containers

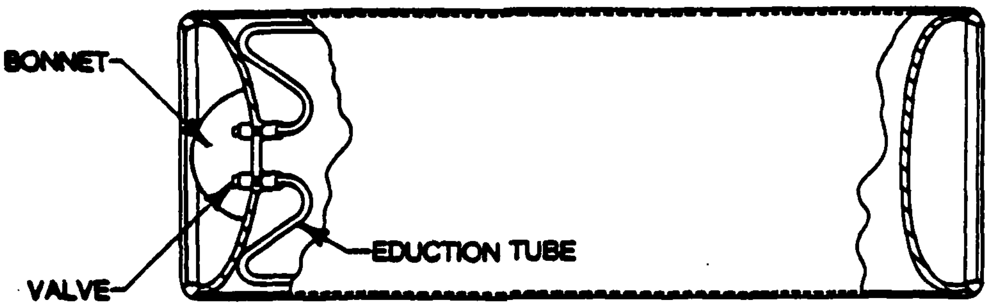


LENGTH	185 in.
DIAMETER	22.5 in.
TOTAL WT.	1935 lb.
AGENT	VX
AGENT WT.	1356 lb.
FUZE	None
BURSTER	None
EXPLOSIVE	None
EXPLOSIVE WT.	N/A
PROPELLANT	None
PROPELLANT WT.	N/A
PRIMER	None
QD/SCG	8A
PACKAGING	1 tank/steel container

Fig. F-32. Tank, spray, VX, TMU-28/B

840099-87

Fig. F-33. Spray tanks are stored individually in CNU-77/E23 storage and shipping containers



LENGTH	81.5 in.		
DIAMETER	30.1 in.		
TOTAL WT.	3100 lb.;	2900 lb.;	3000 lb.
AGENT	HD	GB	VX
AGENT WT.	1700	1500	1600
FUZE	None		
BURSTER	None		
EXPLOSIVE	None		
EXPLOSIVE WT.	N/A		
PROPELLANT	None		
PROPELLANT WT.	N/A		
PRIMER	None		
QD/SCG	8A		
PACKAGING	None		

TON CONTAINER

Fig. F-34. Ton container

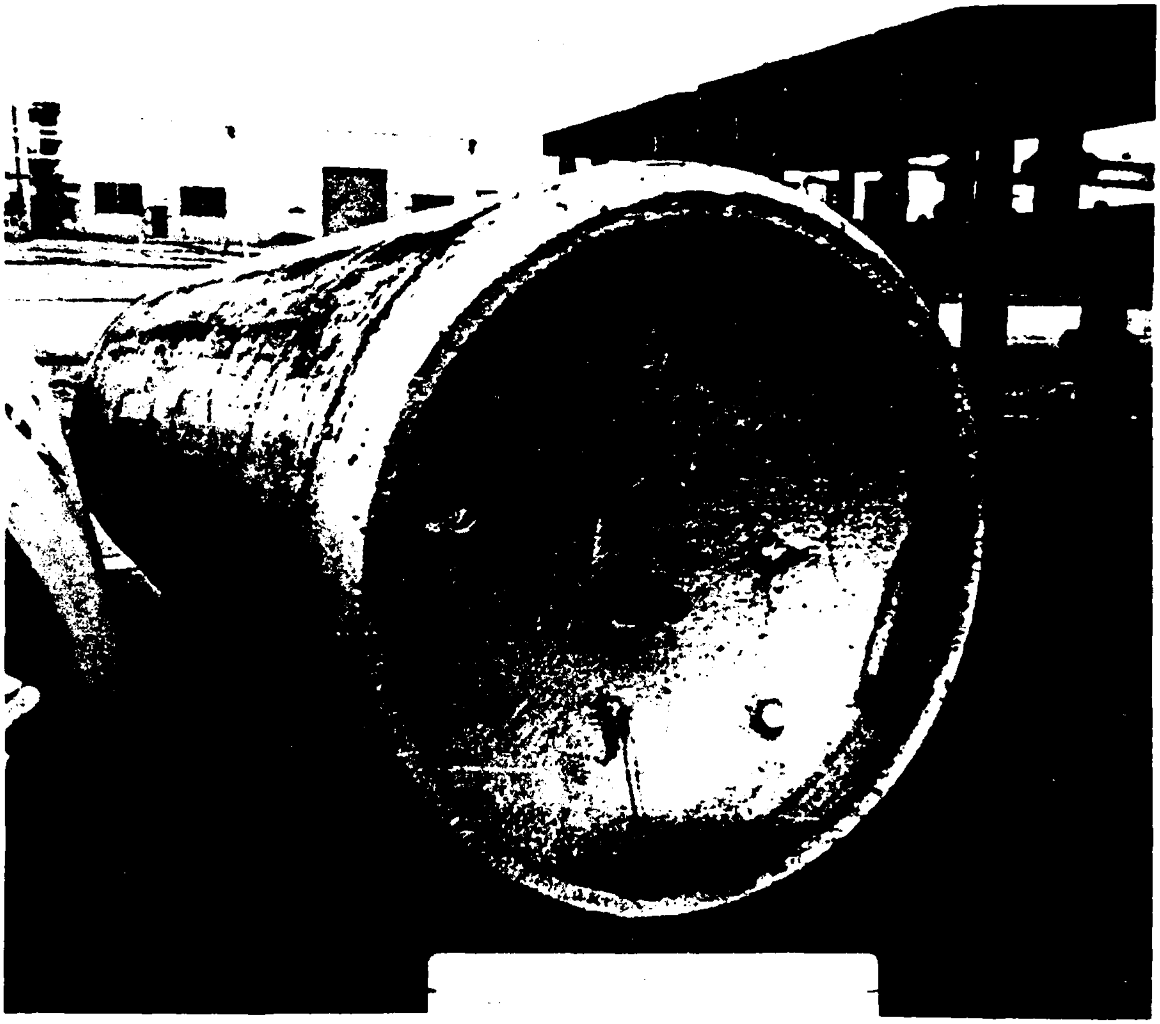


Fig. F-35. Ton containers store chemical agents in bulk form

F.1.2. BURSTER DETONATION THRESHOLD

Stimuli which can initiate detonations in high explosives include (Ref. F-2):

- Shock initiation.
- Impact initiation.
- Thermal initiation.
- Friction.
- Static electric discharge.

High explosives can always be detonated by sufficiently strong shock waves because that is their mode of initiation in normal use. By design, burster reaction initiated by either friction or static electric discharge is considered incredible. In addition, secondary high explosives are relatively insensitive to shock and impact initiation for safety in use, transportation, and storage. Nevertheless, accidental detonation of munitions is considered credible when the munitions are subjected to undue force arising from an accident. A measure of the sensitivity of the munitions to accidental impact is indicated by the Susan test. In this test, the ignition point of the high explosive is determined as a function of impact velocity. Given the explosive confinement designed into the munition, ignition can be interpreted as leading to a violent explosion. According to Ref. F-3, the threshold velocity for ignition is about 180 ft/s (123 mph) for COMP B-3 and 235 ft/s (160 mph) for TNT. COMP B-3 and TNT are major components of the munition bursters. These velocities are well above any credible impact velocity arising from the accident scenarios considered herein except the aircraft crash. However, spontaneous, or unexplained detonations have been known to occur. Therefore, the possibility of a detonation is evaluated for those accidents which may introduce an undue force as part of the accident scenario.

F.1.3. THERMAL FAILURE THRESHOLDS

The thermal failure threshold is defined as the time to fail the agent compartment when the munition is enveloped by fire. In the case of burstered munitions, including those which are also packaged with propellant, the thermal threshold may be a violent detonation. For non-burstered munitions, failure occurs by rupturing the agent-containing vessel because of internal pressure buildup associated with the addition of heat. The thermal failure thresholds for the various munition types were determined by analysis (Refs. F-4 and F-5). They are shown in Table F-1. Two fire scenarios were considered: (1) direct heating of a munition by an 1850°F fire and (2) indirect heating of a munition whereby the fire heats a 1/4-in. steel plate positioned 6 in. from the munition. The air space between the plate and the munition is considered static with heat transfer occurring by conduction and radiation.

As shown in Table F-1, the results indicate that burster detonation occurs before hydraulic rupture. When subjected to direct exposure to a fire, rockets can detonate in as little as 4 min, and cartridges and projectiles in 6.5 min. A significant increase in exposure time is generally predicted for an indirect fire. This would correspond to the munitions in an uninsulated steel overpack such as a rocket sport, or the vault container to be used for offsite transportation. The corresponding times to reach detonation temperature are 10.5 min for rockets, 75 min for cartridges, and 89 min for projectiles.

The nonburstered munitions are subject only to hydraulic rupture when enveloped by fire. The predicted exposure time to reach failure (Table F-1) is typically about 30 min for direct exposure to fire and typically more than 2 h for indirect exposure.

TABLE F-1
CALCULATED THERMAL FAILURE THRESHOLDS

	Direct Exposure	Indirect Exposure
Cartridges[a]		
Burster detonation	6.5 min	75 min
Hydraulic failure	11 min	>2 h
Propellant ignition	6 min	49 min
Projectiles[a]		
Burster detonation	6.5 min	89 min
Hydraulic failure	12 min	>2 h
Bomb[a]		
Hydraulic failure	35 min	>2 h
Ton containers[a]		
Hydraulic failure	30 min	>1 h
Spray tank[a]		
Hydraulic failure	>2 h	>2 h
Mine[a]		
Burster detonation	16 min[b]	68 min
Rocket[c]		
Buster detonation	4 min	10.5 min
Propellant ignition	5 min	13.7 min
Hydraulic failure	7 min	12 min

(a)One-dimensional calculation with radiation heat transfer.

(b)For individual mine (not in drum), based on test data from Ref. 5-11.

(c)Multi-dimensional calculation with convection and radiation heat transfer.

F.1.4. MECHANICAL FAILURE THRESHOLDS

Limited information was available from other studies to define the munition mechanical failure thresholds. H&R Technical Associates reported both calculated and test results relevant to the M55 rockets (Ref. F-5). In addition, H&R Technical Associates calculated the mechanical failure thresholds for other munitions (Ref. F-6). The results of the calculated crash, impact, and puncture failure thresholds are shown in Table F-2. The results of impact tests available at the start of the risk analysis are summarized in Table F-3. The results of additional impact tests performed in July 1986 are discussed in a subsequent section.

The crush threshold is defined as the static load required to deform the munitions beyond their yield strength. Two crush threshold values are presented in Table F-2, one for axial load and another for a side load. The calculation of the axial, or end crush threshold of a single bare munition assumes that the crushing force is applied parallel to the axis against the end of the munition and that the force is equally distributed over the munition cross section. The weakest portion of the munition cross section is assumed to be the portion of the agent compartment with the thinnest wall. The side crush of a bare munition was calculated based on the assumption that the crushing force applies perpendicular to the axis against the side of the munition and that the force is equally distributed along the length of the munition. The wall thickness is assumed to be uniform along the wall. For the calculation of the end and side crush thresholds of a packaged munition, the smallest end of a pallet was chosen to be crushed on a surface. This assumes a perfectly planar fit between the pallet and its crushing surface. The pallet is also assumed to be resting on a perfectly inelastic massive surface.

The impact threshold is defined as the velocity of impact against an unyielding surface which will deform the munition beyond its failure

TABLE F-2
CRUSH, IMPACT, AND PUNCTURE CALCULATION RESULTS FOR CHEMICAL MUNITIONS

Munition Type	Axial Crush Force(A) (lb)	Axial Impact Velocity(B) (fps/mph)	Axial Impact Height (ft)	Side Crush Force(C) (lb)	Side Impact Velocity(D,AE) (fps/mph)	Side Impact Height(AE) (ft)	Forklift Puncture Velocity(E) (fps/mph)	Road ACC Puncture Velocity(F) (fps/mph)	Rail ACC Puncture Velocity(G) (fps/mph)
Weapons Containing Agent, Fuze, and Burster									
Propellant-Assembled(Z,X)									
115-mm M55 rocket in M441 S/L tube (wt 67 lb)	40,600	57/39	50	20,600(I)	41/28	26			
Palletized weapons - 15/pallet - (wt 1,350 lb)	608,000	49/34	38(AA)	43,400(J)	13/09	3(AA)	1/01	2/01	6/04
4.2-in. M2/M2A1 cartridge (wt 25 lb)	152,000	180/123	503	18,400	63/43	61			
Special M55 pallet calculation(AF)	—	—	—	112,000(AF)	51/35(AF)	40(AF)	—	12/8(AF)	25/17(AF)
Palletized in wooden boxes - 2/box - 24 boxes/pallet (wt 1,700 lb)	7,300,000	149/102	345	110,000	18/12	5(AA)	2/01(K)	5/04(K)	7/05(K)
105-mm M60/M360 cartridge (wt 32 lb)	279,000	216/147	726	61,000	101/69	158			
Palletized in wooden boxes - 2/box - 15 boxes/pallet (wt 1,880 lb)	8,370,000	155/105	371	306,000	30/20	14(AA)	4/03(K)	14/09(K)	20/14(K)
Weapons Containing Agent, Burster									
Assembled - Exposed(Z)									
155-mm M104/M110/M121/M121A1/M122 projectile (wt 99 lb)	621,000	183/125	522	155,000(L)	79/54	97			
Palletized weapons - 8/pallet - (wt 832 lb)	4,960,000	178/122	497	230,000(L)	39/26	24(AA)	5/04	20/14	25/17(AF)
8-in. M426 projectile (wt 199 lb)	1,170,000	178/121	491	181,000(L)	70/48	76			
Palletized weapons - 6/pallet - (wt 1,253 lb)	7,030,000	174/118	468	361,000(L)	39/27	24(AA)	6/04	15/10	22/15
750-lb MC-1 bomb (wt 725 lb)	1,290,000	98/66	148	54,500(M)	40/27(N)	25			
Palletized weapons - 2/pallet - (wt 1,575 lb)	2,580,000	94/64	137	54,500(M)	27/19(N)	11(A)	4/03	8/05	10/07
Assembled in Containers(Y,Z)									
500-lb MK 94 bomb (wt 440 lb)	981,000	109/75	186	35,800(M)	30/20(O)	14			
Containerized weapons - 1/container - (wt 530 lb)							4/03(K)	16/11(K)	23/16(K)
MK-116 bomb (wt 562 lb)	224,000	48/33	33	8,160(L)	13/9(O)	3			
Containerized weapons - 1/container - (wt 851 lb)	486,850	55/38	47(AA)	14,900(L)	22/15(Q)	8(AA)	3/02(R)	8/06(R)	10/07(R)

TABLE F-2 (Continued)

Munition Type	Axial Crush Force(A) (lb)	Axial Impact Velocity(B) (fps/mph)	Axial Impact Height (ft)	Side Crush Force(C) (lb)	Side Impact Velocity(D,AE) (fps/mph)	Side Impact Height(AE) (ft)	Forklift Puncture Velocity(E) (fps/mph)	Road ACC Puncture Velocity(F) (fps/mph)	Rail ACC Puncture Velocity(G) (fps/mph)
Weapons Containing Agent, Fuze and Burster									
Unassembled(Z)									
M23 mine (wt 23 lb)	73,513	131/89	266	711	13/09	3	(W)	(W)	(W)
Containerized weapons - 3/drum - (wt 115 lb)	88,593	64/44	64	18,000(AG)	30/20(Q)	14(AA)	1/01(V)	2/01(V)	3/02(V)
Palletized drums - 12/pallet - (wt 1,337)	531,558	46/31	33(AA)	72,000(AG)	18/12(Q)	5(AA)			
Weapons Containing Agent - in Containers(Y,Z)									
TMU-28 spray tank (1,935 lb)									
Containerized weapons - 1/container - (wt 6,000 lb)	3,390,000	55/38	47	59,900	25/17(T)	10(AA)	10/07(U)	10/07(U)	12/08(U)
Shipping Containers - Agent(Z)									
Type E (wt ~3,000 lb)	969,000	42/28	27	11,900	9/6(N)	1	2/01	2/02	3/02
Type A, D (wt ~3,000 lb)	1,510,000	52/35	42	54,000(AG)	14/10(N)	3(AG)	3/02	4/03	5/03
Overpacked container (wt ~9,000 lb)	2,014,560	35/24	19	12,780(AB)	7/5(AC)	1	7/05(AD)	5/03(AD)	7/04(AD)
Weapons Containing Agent									
105-mm M60/M360 projectile (wt 32 lb)	279,000	216/147	726	61,200	101/69	158	4/03	14/09	20/14
Palletized weapons - 24/pallet - (wt 799 lb)	6,690,000	212/145	698	245,000	41/28	26(AA)			

A. Unless otherwise noted, the calculational model is a simple pipe crushed by an axial force bearing on the pipe annulus.

B. No credit is given for shock absorbing effects of pallet or packing materials. Both the weapon and the pallet or container are assumed to free fall to failure.

C. Unless otherwise noted, the calculational model is a simple pipe with closed ends: the crush force is distributed across the crest of one side with a reaction force at each end creating a bending moment. The weakest side of the pallet was chosen for crush force application where one pallet side was larger than another.

D. No credit is given for shock absorbing effects of pallet or packing materials. Both the weapon and the pallet or container are assumed to free fall to failure. The pallet is assumed to land on its weakest side.

E. A forklift with a mass of 5000 lb requires this velocity to puncture the weapon with a tine. No shock absorbing effects or pallet sliding considered.

TABLE F-2 (Continued)

F. Inside a truck body, a metal rod 1-1/2 in. diameter requires this velocity to be driven into the weapon with the weight of one pallet behind it.

G. Inside a railcar, a metal rod 3 in. diameter requires this velocity to be driven into the weapon with the weight of one pallet behind it.

H. The M55 is close fitted into a shipping/launch tube which is included in the models. The rocket weighs 57 lb; 10 lb are added for the S/L tube.

I. The force required to crush the 40 in. of warhead is used.

J. The force required to crush the saddle supports into the warhead portion of the rockets is used.

K. The wooden box or aluminum container are assumed to provide negligible protection to the munition.

L. The crush force is assumed to bear on only 2/3 of the side of the munition.

M. The crush force is assumed to bear on only 1/2 of the side of the munition.

N. A side wall deformation of 4 in. is assumed to be required for failure.

O. A side wall deformation of 2 in. is assumed to be required for failure.

P. The aluminum container is assumed to provide no protection from crush, impact, puncture.

Q. A side wall deformation of the container of 5 in. is assumed to be required for failure.

R. The puncture probes must travel 4 in. into the container for failure.

S. The TMU-28 wall is assumed to be much weaker than the container wall.

T. A side wall deformation of the container of 12 in. is assumed to be required for failure.

U. The puncture probes must travel 20 in. into the container for failure.

V. The puncture probes must travel 3 in. into the container for failure.

W. The puncture force required to puncture the container is sufficient to puncture the munition also.

X. Some assembled cartridge versions of the M60/M360 are assumed to have been cannibalized for fuzes and propellent.

Y. Fuzes or explosive cutters are assumed to have been removed.

Z. Unless otherwise noted impact and puncture deformations of 1 in. cause failure.

AA. These heights represent perfect impact into a totally massive surface with no energy absorption by the weapon packaging. It is assumed for velocities below about 50 fps (39 ft equivalent height), energy absorbtion by weapon packaging and the surface will dominate the energy of the collision. In these cases test data are of more value.

AB. This represents a crush force applied over 36 in. of the thin wall portion of the container.

AC. A side wall defomation of 7 in. is assumed to be required for failure.

AD. The puncture probes must travel 5 in. into the container for failure.

AE. The calculated impact failure threshold data listed were superceded by test data. Therefore, the calculated values are shown for reference only.

AF. A multi-dimensional crush and impact analysis and a sophisticated puncture calculation were performed only for the M55 pallet.

AG. Based on test data.

TABLE F-3
TEST DATA CORRESPONDING TO EFFECTS OF IMPACT

Munitions Configurations	Number Tested	Components Present	Test Dates	Test Procedure	Test Results
Cartridges			No test data available for this report		
Projectiles					
155-mm (no packaging)	1	Burster	1975(a)	25 10-ft drops on steel plate and concrete for: • Base • Side • Nose	No failures for base/side drops, agent compartment failure in 11th nose drop
8-in. (no packaging)	30	Burster	1961(a)	40-ft nose drops on steel plate and concrete	No failures recorded
	30	Burster		40-ft side drops on steel plate and concrete	
	30	Burster		40-ft base drops on steel plate and concrete	
Bomb					
MC-1 750-lb bomb (no packaging)	2	Burster	1955(a)	6-ft side drop on steel plate and concrete	No failures recorded
	2	One with burster only, one with burster and fuze	1955(a)	30-ft side drop on steel plate and concrete	No failures recorded
	2	Fuze/booster	1971(b)	Dropped from plane at 387-ft and 280-mph onto concrete	Hit at 285-mph, bounced 88-ft high, no failures recorded

TABLE F-3 (Continued)

Munitions Configurations	Number Tested	Components Present	Test Dates	Test Procedure	Test Results
Containers					
TMU-28B spray tank (no packaging)	2	Simulant	1973(a)	10-ft side drop on concrete	No failures recorded
	1	Simulant	1966(a)	10-ft side drop on concrete	No failures recorded
	1	Simulant	1968(a)	10-ft side drop on concrete	No failures recorded
Type D ton container (no packaging)	1	Simulant	1964(c)	40-ft drop on steel (end)	Leakage
	1			40-ft drop on steel (35-deg angle)	Major leakage
	1			40-ft drop on steel (side)	Major leakage
	1			6-ft drop on concrete (end, corner, side)	No leakage
Mines					
M23 mine only	3 (8 drops each)	No burster	1958(d)	6-ft drop on steel plate and concrete (side, top, end edge)	Visible leak on last of 24 drops
M23 mine only (prototype)	5 (2 drops each)	Side and central burster	1960(d)	6-ft drop on steel plate and concrete	No leaks
M23 mine only (prototype)	30	Inert bursters agent-filled	1960(d)	3-ft drop on gravel road at 30 mph	One mine had trace leak

TABLE F-3 (Continued)

Munitions Configurations	Number Tested	Components Present	Test Dates	Test Procedure	Test Results
M23 mine only (prototype)	41	Side and central bursters M120 bursters	1960[d]	4-ft drop on concrete slab	Two mines had small leaks
Rockets					
Complete pallet	1	Agent simulant	1964[e]	40-ft drop onto concrete (nose 30 deg below horizontal)	Both end sheets dislodged, one firing tube cracked and enclosed warhead bent so that could not be fired, no agent leaked or propellant function.
Complete pallet	1	All	N/A[a]	40-ft accidental drop onto steel cargo deck, nose down	Pallet "destroyed" scattering all rockets, 14 of 15 rockets damaged, no agent leakage or propellant function.

TABLE F-3 (Continued)

Munitions Configurations	Number Tested	Components Present	Test Dates	Test Procedure	Test Results
Weteye Bomb					
Bomb in shipping container	2	Agent simulant	1965[f]	40-ft drop onto steel plate embedded in concrete (end and side)	For both end and side drop, the shipping container seal no longer effective, bomb nose bent, no agent leakage.

[a]Reference F-7.

[b]Reference F-8.

[c]Reference F-9.

[d]Reference F-10.

[e]Reference F-11.

[f]Reference F-12.

point. The end (axial) and side impact forces on single and palletized munitions were originally determined analytically and whenever possible, supported with test data. Sufficient drop test information was available on the M55 rocket pallets (Table F-3) to determine that simple analyses were not adequate; therefore, multidimensional, nonlinear analyses were conducted (Ref. F-5). This resulted in defining the impact failure threshold as a 40-ft drop height for M55 rocket pallets rather than 3-ft as calculated by simple analysis shown in Table F-2. Therefore, the calculated impact failure thresholds for the other munitions were also considered to be overly conservative, and additional tests were performed at DPG to better define the impact failure threshold for the various munitions. These are discussed in a subsequent section.

The puncture threshold is defined in terms of a ratio of velocity to radius of curvature of the puncture object assuming that the munition (or the pallet) impacts an unyielding slender object. If there is more than one protective barrier, (e.g., mines packaged in drums), the threshold is the velocity required to puncture all the barriers. The puncture failure threshold was determined by calculating the force required to cause material failure with a slender object. During handling operations, munition puncture failures will most likely be caused by forklift tines. The puncture velocity was calculated based on a typical 5000-lb forklift. The munitions are assumed to be in their stored or shipped configuration, as appropriate. Wooden and aluminum containers are assumed to provide no protection to a probe. Some material deformation is also assumed and is consistent with the assumptions made for crush failure threshold calculations. Based on the SNL data base, the calculated truck accident puncture velocity assumed a 3/4-in. radius probe, while the railroad accident puncture velocity assumed a 1.5-in. radius probe. These probe sizes are considered the most probable for truck and rail accidents. In each case, the most likely object capable of acting as a probe was considered to be a trailer/railcar coupler.

F.1.5. ADDITIONAL TEST DATA FOR MECHANICAL FAILURE (IMPACT) THRESHOLDS

In the risk analysis, the objective is to determine the probability that a munition will fail and release agent to the environment. Early Army tests, however, were designed to verify that properly packaged muitions would withstand certain guideline loads rather than to determine the point at which a failure would occur. A summary of various impact tests on chemical munitions is given in Table F-3. The results in Table F-3 indicate that the calculated failure thresholds for impact shown in Table F-2 are too conservative. The one-dimensional mechanical calculations appear to be reasonable for puncture and crush failure, but the modeling is not sufficiently sophisticated to consider the impact energy absorption of the wood, cardboard, and styrofoam protective packaging or the load spreading capability of the shipping configuration. (Multidimensional calculations were performed only on the M55 rocket.) To determine the impact failure thresholds of munitions more accurately, tests were conducted in July 1986 on mines, ton containers, cartridges, and projectiles at DPG. The test results are summarized in Table F-4 and are discussed below. All munitions contained the appropriate quantity of agent simulant. All drops were onto a 10- x 10- x 1-ft concrete slab reinforced with standard bar and angle strips of steel. For some tests, the pad also had a special hard concrete surface.

Two drop tests were conducted with 30-gal drums, each containing three M23 mines. The first drop was from a height of 60 ft such that the side of the drum impacted the cement; substantial leakage of the simulated agent resulted. For a second drop, at 45 ft and in the side orientation, no failures occurred. Figure F-36 shows the three mines after they had been removed from the drum dropped 45 ft. Note that the side of each mine was deformed.

Five ton containers were dropped in eight tests. The first ton container was dropped from three heights, (15, 30, and 40 ft) in a side orientation. After the first test, the ton container was rotated

TABLE F-4
JULY 1986 DROP TESTS

Munitions Configuration	Components Present	No. of Tests	Test Description	Test Results
2 Mine drums containing three M23 mines each	Non-burstered simulant filled	1	45 ft drop, side orientation	Deformation in side of each mine, no leaks.
		1	60 ft drop side orientation	Major leak
6 Ton containers, no overpack	Simulant filled	3 of 1	15, 30, and 40 ft, side orientation	Leak from 4 in. crack after the third drop.
		3	40 ft drop, side orientation	No leaks
		2	40 ft drop at 45 deg angle	No leaks
6 Pallets of 15 M360 105-mm projectiles each	Non-burstered simulant filled	1	60 ft drop, 1 pallet, side orientation	No leakage from any of the tests. Typically, pallet was shattered, but projectiles showed little effects.
		1	60 ft drop, 2 pallets banded together, side orientation	
		1	60 ft drop, 1 pallet, impact along edge	
		1	60 ft drop, 1 pallet, impact on nose ends of projectiles	
		1	60 ft drop, 1 pallet, impact on corner of nose end	
2 Pallets of six 155-mm projectiles each	Non-burstered simulant filled	1	60 ft drop, 1 pallet, impact along edge	No leaks. Projectiles showed only slight effects.
		1	60 ft drop, 1 pallet, impact on corner of nose end	
2 Pallets of 48 4.2 in. mortars each	Non-burstered simulant filled	1	60 ft drop, 1 pallet, impact along edge	No leaks. Boxed generally broken, but no evidence of munition damage.
		1	60 ft drop, 1 pallet, impact on corner of nose end	

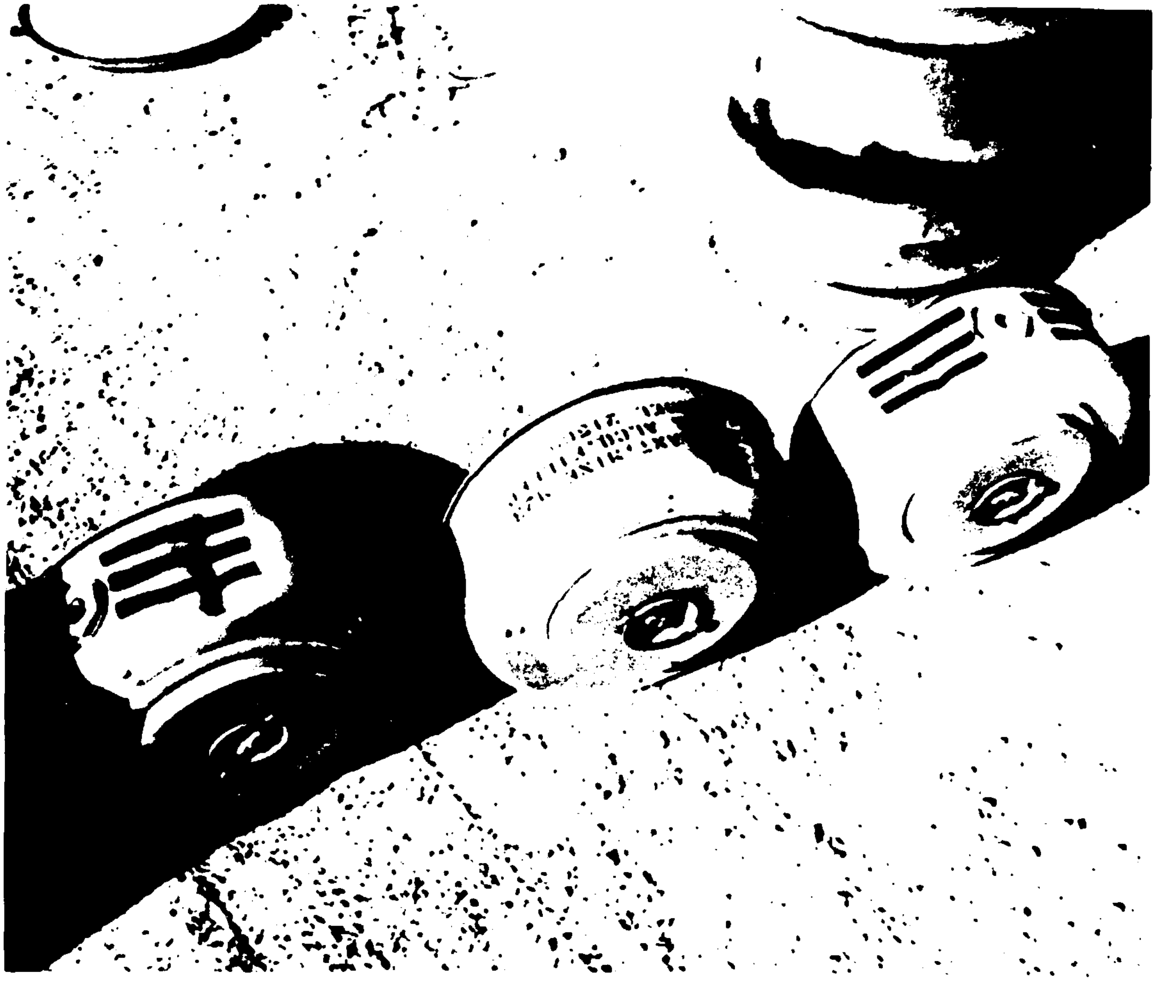


Fig. F-36. Land mines after 45-ft side drop in a 30-gal drum

about 90 deg, and after the second test, the cylinder was rotated about 45 deg. The first two tests produced flat spots along the length of the cylinder. On the third drop of the first container, leakage of the agent simulant was observed from a 4-in. long crack on the inside of the protective cylindrical apron in the vicinity of the head weld. Since the crack appeared to emanate from the flat spot created from a prior drop, it was postulated that the failure occurred because of the multiple drops experienced by the cylinder. The postulate was confirmed by three more drops of three separate cylinders, all in a side orientation from 40 ft: no leakage occurred. Figure F-37 shows the flat spot, about 6-in. wide, created by a typical 40-ft drop in a side orientation. Two additional cylinders were dropped from 40 ft, but at a 45 deg angle. The protective apron was bent but no leakage occurred. Figure F-38 shows the deformed apron.

Two pallets of 4.2-in. mortars were dropped from 60 ft, the highest drop height possible with the crane that was used. The orientation of the first drop was such that the edge of the pallet, along the length of the munition, initially impacted the cement. No deformation of the munition itself occurred and no leakage was observed, although most of the wooden boxes were broken open and some of the cardboard tubes were damaged. The munitions were removed (at least partially) from the four cardboard tubes that were the most damaged and stacked in the midst of the undisturbed remnants of the pallet (Fig. F-39). In a second test from 60 ft, the pallet was oriented so that the corner (with the nose of the munition) initially struck the cement. Similar damage to the pallet dunnage occurred, but the munition itself was undamaged.

Six pallets of M360 105-mm projectiles were dropped in five tests, all from 60 ft: (1) a single pallet oriented to strike the side containing the fewest munitions (three); (2) two pallets banded together and oriented to strike the side containing the fewest munitions; (3) a single pallet oriented so that the pallet edge along the length of the munition would initially impact the cement; (4) a single pallet oriented

Fig. F-37. Ton container after 40-ft side drop

Fig. F-38. Ton container after a 40-ft drop at a 45-deg angle

Fig. F-39. 4.2-in. mortar shells after a 60-ft drop from a pallet

so that the 15 nose ends initially impact the cement; and (5) a single pallet oriented so that the corner of the pallet containing the nose of a munition would initially impact the cement. The last test produced the most damage to the munition, but no leakage occurred. Figure F-40 shows that the worst damage was a slightly deformed nose end.

Two pallets of 155-mm projectiles were dropped from 60 ft. One was oriented so that the edge of the pallet along the munition length impacted first and the other so that the corner of the pallet with the projectile nose initially impacted. The munitions generally were undamaged except for the paint and some bruising of the brass rotating band. For the corner drop, the nose ring of the munition in the corner was broken as shown in Fig. F-41.

F.1.5.1. Basis for Selection of Impact Failure Thresholds

The drop test data clearly demonstrated that the calculated failure thresholds are extremely conservative. The drop tests were able to provide a more realistic estimate of the impact failure threshold for rockets, mines, and ton containers. However, the tests were limited to a drop height of 60 ft and no failures or severe damage were observed for cartridges and projectiles. Thus, the actual failure thresholds for these "stronger" munitions could not be established directly from tests. For these munitions, and also bombs and spray tanks, the impact failure threshold was inferred by scaling analytical results using scaling factors obtained from test data on similar munitions.

Rocket. Two rocket pallet drops have occurred from a height of 40 ft (Table F-3); neither produced failure, although in one case the nose of one rocket was severely bent, indicating that the failure threshold for the worst orientation may not be much higher. In addition, conservative calculations indicated failure at 40 ft. Thus, 40 ft was selected as the failure threshold.

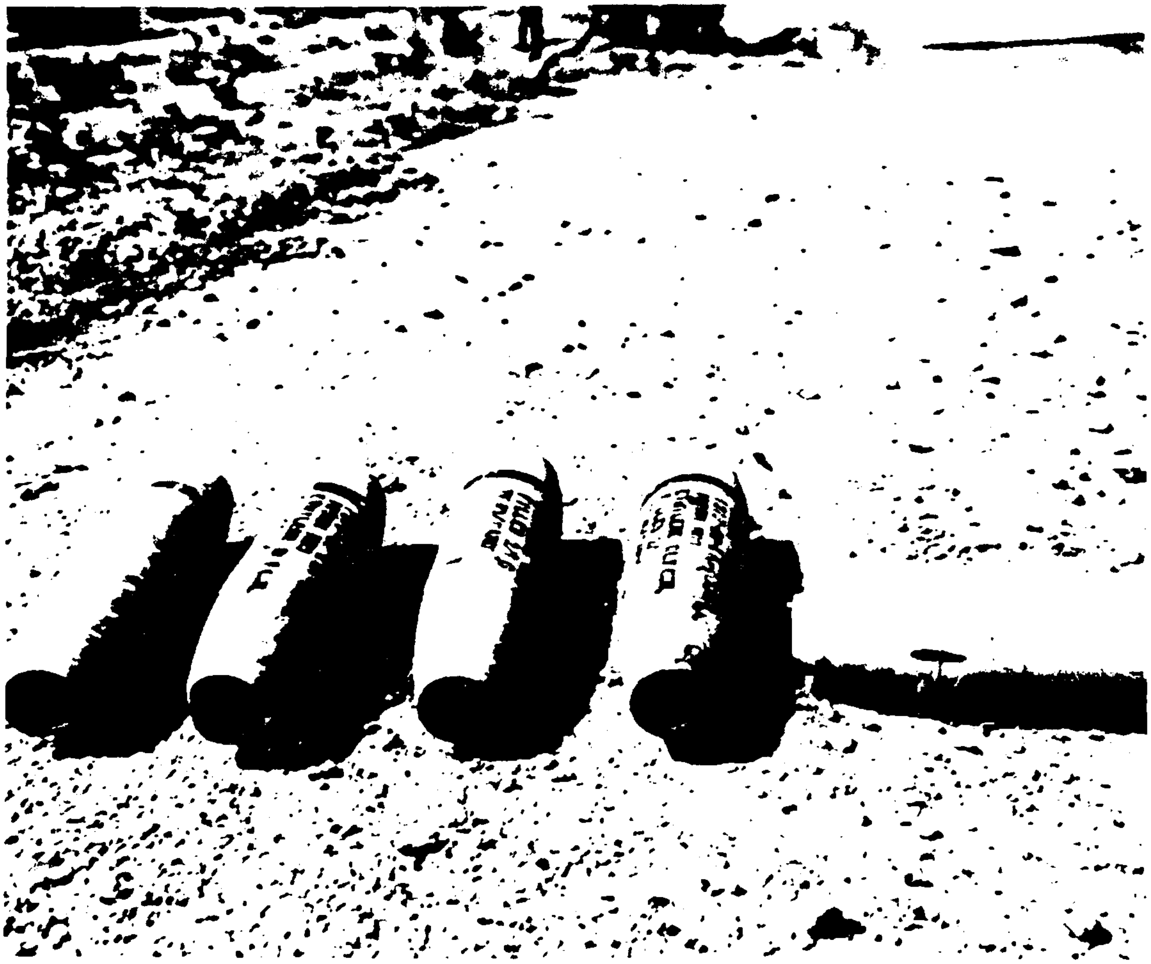


Fig. F-40. 105-mm projectiles of a pallet after a 60-ft drop

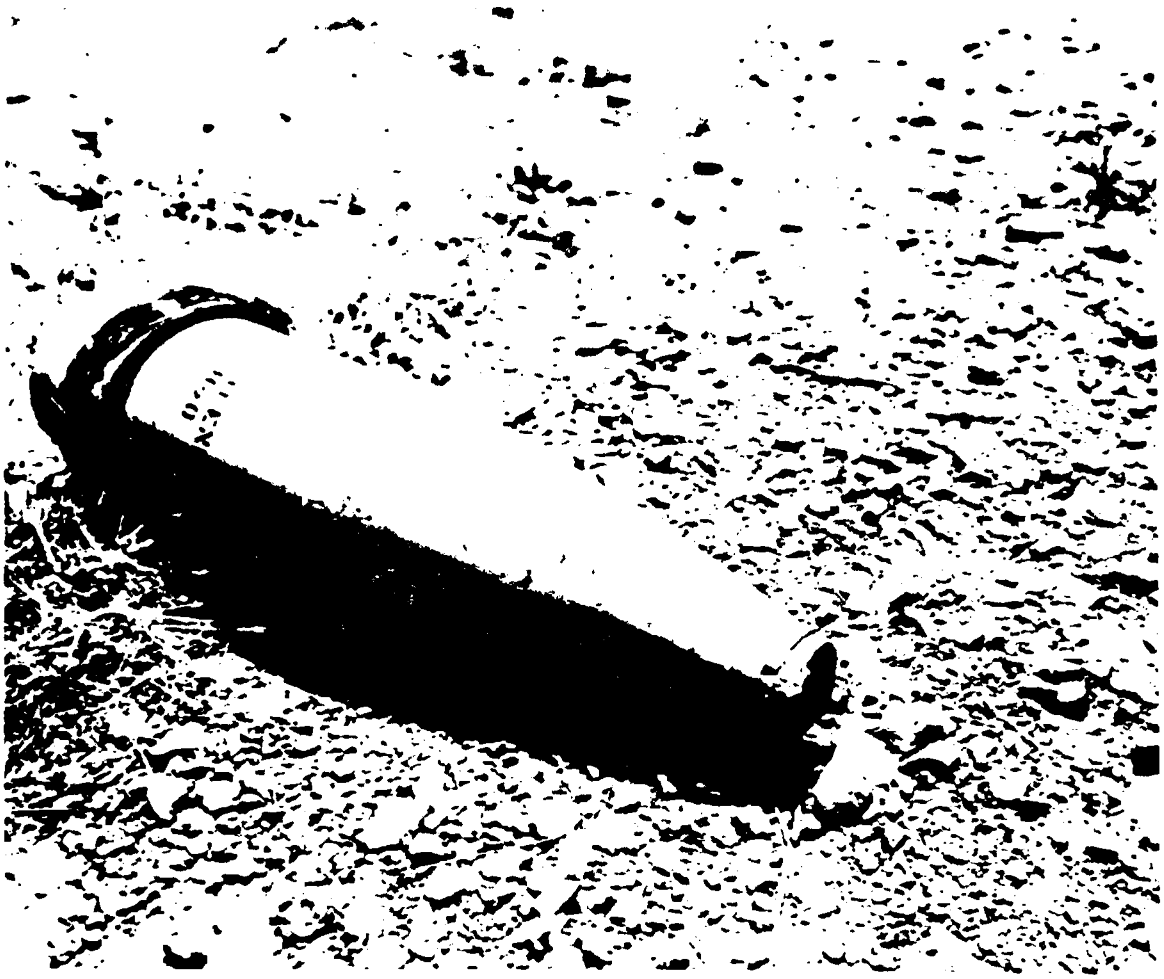


Fig. F-41. 155-mm projectile after a 60-ft drop from a pallet

Mine. Two tests with individual drums of mines resulted in agent containment failure at a drop height of 60 ft and no failure at 45 ft (Table F-4). The mine body deformation at the 45-ft drop height, however, indicated that other drops at 45-ft, or even slightly less, could produce failure. Thus, 45 ft was selected as the failure threshold. Due to the energy absorption capability of the styrofoam packaging, it was judged that the effect of palletizing the drums is negligible.

Ton Container. A prior test produced failure for a 40-ft side drop, and a 40-ft, 45-deg drop (Table F-3). The more recent tests produced no failures for three side drops and two 45-deg drops from 40 ft, using five different ton containers (Table F-4). Failure did occur in one ton container for a side drop from 40 ft after it had already been dropped from 15 and 30 ft. Thus, the failure threshold was selected as 40 ft. The analytical estimate was 3 ft. A scale factor of 13 is obtained between the analytical estimate and the test data.

Bomb. In two prior tests, an MC-1 750-lb bomb was dropped from a plane traveling at a height of 387 ft and a speed of 285 mph (Table F-3). The bomb impacted a concrete runway at an average terminal velocity of 283 mph; the height of the first bounce averaged 88 ft. No leakage of the agent simulant occurred. The impact orientation of the bomb was not given in the test report; however, the vertical component was estimated as 105 mph. The equivalent drop height corresponding to 105 mph is 368 ft. It was assumed that the effect on the bomb more closely resembled a pure axial load rather than a pure side load. The analytical estimate for an axial load was 148 ft (Table F-2).

The bomb is similar to a ton container, and hence the scaling factor of 13 obtained for the ton container for a side load will be used to estimate the failure threshold for a side load on the bomb. The analytical estimate for a side impact load was 25 ft (Table F-2). Hence, the failure threshold for the bomb can be estimated to be 325 ft (25 x 13).

105-mm, 155-mm, and 8-in. Projectiles. Two types of projectiles (105 mm and 155 mm) were dropped from 60 ft (Table F-5) with no observed failures. The M110, 155-mm projectile has a calculated failure threshold of 24 ft (Table F-2). Thus, an apparent scaling factor of at least 60/24 = 2.3 exists between the calculated and experimental failure thresholds. Test limitations precluded dropping projectiles from heights greater than 60 ft; hence, a scaling factor was used to get a more realistic failure threshold. The scale factor of 13 obtained for the ton container was used to determine the failure threshold of projectiles. A failure threshold of 312 ft (24 x 13) was obtained for the 155 mm projectiles. The projectile representative munition is the M426, 8-in. projectile which also has a calculated failure threshold of 24-ft, but no tests were performed with 8-in. projectiles. Hence, the failure threshold for the 155 mm was used as an approximate failure threshold (312 ft) for the 8-in. projectile.

4.2 in. Mortars. Palletized cartridges were calculated to fail at a drop height of 5 ft (Table F-2). In the test, cartridges were dropped from a height of 60 ft (Table F-4), the maximum height permitted by test limitations. There were no deleterious effects on the munitions, only the dunnage was affected. If a scaling factor of 13 is used, an estimated drop height of 65 ft (13 x 5) is obtained. Since no damage occurred at 60 ft, a value of 65 ft is too low. This is partly due to conservative analytical estimate (5 ft) when energy absorption due to dunnage was omitted. The cartridge is weaker than the bomb or the projectile, but should have a failure threshold greater than 60 ft. Hence, in the absence of any other data a mean value (180 ft) between the projectile and test data of 60 ft will be used as an approximate failure threshold for the cartridges (312 + 60/2).

Weteye Bomb. Data reported in the Weteye Final Environmental Impact Statement (FEIS) indicate that the bomb in its shipping container did not fail but was severely damaged for drop tests from 40 ft for

TABLE F-5
ESTIMATED IMPACT FAILURE THRESHOLD FOR MUNITIONS
IN SHIPPING CONFIGURATION

Munition	Failure Threshold Drop Height (ft)	Basis	Scaling Factor
Rocket	40	(a), (b)	--
Mine	45	(a)	--
Ton container	40	(a)	--
Bomb	325	(c)	13
Cartridge	180	(a), (d)	--
Projectile	312	(c)	13
Weteye	40	(a)	--
Spray tank	50	(c)	5

[a]Test data.

[b]Analytical data.

[c]Scaled analytical data.

[d]Limited data available; mean of test data and projectile estimate.

either side or end orientation (Table F-3). The corresponding calculated side drop failure threshold was 8 ft (Table F-2). Thus, the test data show that the failure threshold is at least five times the calculated value.

Spray Tank. The analytical failure estimate for the spray tank was 10 ft (Table F-2). No tests were performed on the spray tank; however, the spray tank in its shipping container is similar to the Weteye bomb in its shipping container. Thus, the scaling factor obtained for the Weteye bomb was used to estimate the failure threshold for the spray tank. A failure threshold of 50 ft (10 x 5) was obtained for the spray tank.

F.1.6. REFERENCES

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APPENDIX G
DEMILITARIZATION ACTIVITIES

G.1. DEMILITARIZATION ACTIVITIES

As noted in Section 3.1, the steps in the demilitarization process were grouped into four major activities for the risk analysis: storage, handling, onsite transportation by truck, and demilitarization operations. Each of these activities, as well as decommissioning, is discussed in detail in the sections which follow.

G.1.1. STORAGE

Safe storage of the chemical munitions is required up to the time they are processed in a demilitarization facility. It is assumed that the current storage arrangement will continue until a process facility or facilities are ready for operation. Large-scale movement of chemical munitions must take place within the constraints of the program schedule, plant operating schedules, logistical limitations of transport operations, and in compliance with safety and regulatory requirements of transport.

Storage of chemical munitions is governed by the general safety guidelines of AMC-R 385-100 (Ref. G-1). Specific regulations for the storage of GB and VX are given in DARCOM-R 385-102 (Ref. G-2), and in DARCOM-R 385-31 (Ref. G-3) for mustard types H, HD, and HT. In accordance with these regulations, it was assumed that the munitions are stored as follows:

1. Magazines or structures used for the storage of agent-filled items are in specially designated areas. The structures have floors and floor surfacing that can be decontaminated.

2. Munitions that contain explosives are stored in igloo magazines. The igloos are spaced according to hazard class and the quantity of explosives that the igloo is permitted to hold.

3. Munitions and bulk containers containing GB or VX, but containing no explosives, are stored in igloo magazines except VX ton containers are in warehouses at NAAP, and VX spray tanks are stored in warehouses at TEAD.

4. Munitions containing mustard, but containing no explosives, are stored in igloos or other approved structures. Bulk containers containing mustard are also stored outdoors at APG, PBA, and TEAD. Mustard-filled bulk containers stored outdoors are secured on metal supports and positioned over crushed stone, gravel, or porous earth surfaces to minimize atmospheric contamination in the event of leakage.

5. Munitions in storage are packaged, stacked, and arranged in accordance with instructions set forth in Army regulations and approved AMC drawings and directives. The methods for stacking provide adequate ventilation. Aisles are maintained so that units in each stack can be inspected, inventoried, and removed for shipment or surveillance tests.

6. The ends of ton containers are kept freshly painted and rust-free to enhance visual detection of agent leakage at valves and plugs. Shipping bonnets are removed from ton containers in storage to facilitate inspection for leakage. If a leaking container is found, the leak is repaired, or the contents are transferred into a new container.

7. Work performed in magazines and storage areas is limited to the types permitted in Chapter 18 (Storage of Explosives and Ammunition) of AMC-R 385-100.

8. Leaking munitions are encapsulated in specially provided containers until disposition is accomplished.

Three types of storage magazines are currently in use: igloo magazines (in 40-, 60-, and 80-ft lengths), 80-ft Stradley magazines, and 89-ft oval-arch magazines. While size and design details differ, they are all earth-covered, arched-roof structures designed to protect their contents from the blast and shrapnel effects of a potential detonation of a neighboring magazine. For this risk analysis, except as noted for specific accident scenarios, the structural characteristics of all the storage magazines are represented by the 80-ft igloo magazine. General design characteristics of the 80-ft igloo magazines are listed below (Ref. G-4):

1. The minimum compressive strength of the concrete used in igloo construction is 2500 psi.

2. The minimum concrete thickness of the igloo arch is 6 in. at the crown of the arch, and the minimum thickness is 16 in. at the foundation footing.

3. The minimum thickness of the exposed concrete front face of the igloo is 18 in.

4. The minimum thickness of the earth cover is 24 in. at the crown of the arch. The earth cover has a maximum slope of two horizontal units to one vertical unit and is stabilized by establishing a controlled vegetation cover such as grass, or by mechanical means appropriate to the local soil conditions and climate.

5. The igloo is designed to prevent water ingress. Preventative measures include membrane waterproofing, a perforated drain system along foundation footings, interior floor slope and gutters, and slope of the concrete entry apron away from the front of the igloo.

6. Passive ventilation is provided in the form of louvered vents in the front concrete face of the igloo and a single ventilator stack penetrating the earthen cover at the rear of the igloo. The stack ventilator is designed to prevent backdrafts.

Fusible links are provided in the vents to close the ventilation path in the event of a fire.

7. Single or double doors, which open outward, are provided in the front face of the igloo. Double doors create an opening measuring 8 by 8 ft. A reinforced concrete "King Tut" block is provided in front of each door as a security device. The block weighs approximately 5000 lb and rests on a post embedded in the concrete apron in front of each igloo; a forklift is required to remove the block from in front of the igloo door. In addition, the doors are padlocked shut with high-security locks.

8. A lightning protection system is provided.

9. No electric power system is permanently installed in the igloos; however, an electrical junction box is provided on the outside front face of each igloo.

10. No fire fighting system is installed in or near the igloos; however, depot fire fighting teams are located within a few minutes response time from the storage locations. In

addition, all nonelectric vehicles are required to carry fire extinguishers when operating in or near the ammunition storage areas. Also, while personnel are operating in the igloos, one or more decon trucks carrying a large supply of water is kept on standby immediately outside the igloo. This water supply can be used for emergency fire fighting if required.

11. An intruder alert system is installed in all igloos.

Warehouses are in use at three sites to store bulk containers. The size and construction of the warehouses are different at each of the three sites. Descriptions of the warehouses are provided in the discussion of site-specific data in Appendix D.

Any munitions in open storage (mustard-filled ton containers) are stored in configurations specified in AMC drawings, but are otherwise unprotected from the elements.

Detailed information on pallet configurations is given in the Continued Storage Risk Analysis report (Ref. G-5).

G.1.1.1. <u>Activities Associated with Storage</u>

The activities associated with munition storage consist of surveillance and maintenance of the stored munitions, surveillance and maintenance of the storage facilities, and inventory of stored munitions. It is assumed that all surveillance will be accomplished in accordance with IAW SB 742-1300-94-1 (Ref. G-6). Three types of inspections are conducted; these are periodic inspections (PI), safety in storage inspections (SSI), and storage monitoring inspections (SMI).

Periodic inspections are cyclical inspections of the munitions for deterioration or nonstandard conditions. Periodic inspections are conducted at 2-yr intervals on all chemical munitions, unless conditions

warrant more frequent inspection. (PI does not apply to munitions in demilitarization accounts.)

Safety in storage inspections are periodic inspections of unserviceable, nonrepairable munitions and munitions in demilitarization accounts, conducted to assure that the munitions are safe for continued storage, handling, and demilitarization. Visual inspections are supplemented by propellant stability testing. Lots that are considered potentially hazardous are inspected no less frequently than the intervals specified for PI. Lots determined to be nonhazardous may have their SSI intervals extended, but the extended interval may not exceed twice the PI interval.

Storage monitoring inspections are performed on chemical agent munitions, containers of bulk chemical agents, and containerized munitions specifically to detect leakers and any other visual defects. Frequency of SMI is as required by technical instructions for the specific item.

At a minimum, all storage facilities (magazines, warehouses, etc.) are inspected at quarterly intervals. The inspections consist of both internal and external visual examinations. Other than appropriate protective clothing and flashlights, no special equipment is required. No moving or restacking of pallets is involved. The inspections address the following:

1. Exterior

- Structural integrity.
- Condition of storage area.
- Vegetation control.
- Clear of dried debris.
- Firebreaks cleared.
- Adequacy of earthen cover.

- Condition of doors and ventilators.
- Correct type of fusible link on vents.
- Lightning protection system.
- Condition of service roads.

2. Interior

- Condition of munitions.
- Compliance with storage drawings.
- Lot segregation.
- Stability of pallet stacks.
- Adequacy of aisles.
- Absence of unauthorized materials or equipment.
- Containers are not damaged.
- Presence of proper records.
- Evidence of termites, rodents, water leakage, or other nonstandard conditions.

Visits to each of the chemical storage sites by the members of the analysis team indicate that the condition of the storage facilities with respect to the above characteristics has been excellent. Only minor repairs for water leakage on igloos have been required.

An enhanced storage monitoring program is in place for the rockets, some of which have experienced vapor leaks. Typically, the inspection involves a three- or four-man team and consists of walking the aisles between the stacks of pallets and making an initial visual inspection for observable signs of agent leakage. Lighting for the storage monitoring inspection is provided by powerful hand-held flashlights. If signs of leakage are found at any time during the inspection, masks are donned and the area is cleared. Following visual inspection, a munition is selected at random for air sampling of the interior of the shipping

and firing tube. Sampling is accomplished in Level B or Level A protective clothing (see Table G-1). The inspection procedure involves no moving or restacking of pallets (unless a leaker is found). All equipment is located on a self-contained cart, which is rolled into the igloo by hand.

Ton containers that are stored in igloos or warehouse buildings are inspected for leakage quarterly (Ref. G-6). Ton containers stored in the open are also required to be inspected quarterly (Ref. G-7). A number of these containers (primarily ton containers with GB) have experienced severe corrosion of the brass fill and drain valves, and some have experienced corrosion in the area of the threaded plugs installed in the container ends. The current plan is to replace the brass valves with stainless steel valves on all GB ton containers. The same degree of corrosion has not been associated with agents other than GB. The corrective procedure for containers containing those agents has been to replace the corroded valves or plugs. This is accomplished with the container filled with agent. While implementing these procedures, Level A protective clothing is worn by all personnel in the immediate vicinity. The procedures involve removing the leaking container from its storage igloo and lifting the container onto a special fixture which will permit the container to be tilted from a horizontal to a vertical orientation. The lifting operation is accomplished with electric forklift, using an M1 lifting bar which is specifically designed to lift a ton container in a horizontal position by engaging both ends of the container with self-locking hooks. Once the container is placed in the fixture, it is tilted to the vertical orientation with the valve end pointing up. The leaking valves are removed, the threads in the container are recut, as required, and a new valve is installed in its place.

Visual examination of the ton containers also reveals the degree of rusting that the containers are experiencing. Specific criteria for allowable rusting are given in SB 742-1 (Ref. G-6). In general, the ton

TABLE G-1
PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT[a]

Protection Level					
A (GB and VX)	B (GB and VX)	C (GB only)	D (VX only)	E (GB or VX)	F (GB or VX)
Protective Clothing					
Suit, TAP[b] (M3) Coveralls, fatigues or protective liner Hood, TAP (M3) Butyl boots with safety toe, TAP (M2A1) Butyl gloves (M3 or M4) Undershirt Drawers Socks Mask-worn (M9 series)	Coveralls or fatigues Hood, TAP (M3 for M9 mask or M6A2 for M17 mask) Butyl boots with safety toe, TAP (M2A1) Butyl apron, extending below top of boots (M2) Butyl gloves (M3, M4, or glove set) Undershirt Drawers Socks Mask-worn (M9 or M17 series)	Coveralls or fatigues Butyl boots with safety toe, TAP (M2A1) Butyl gloves (M3, M4, or glove set) Undershirt Drawers Socks Mask-worn (M9 or M17 series)	Coveralls or fatigues Butyl boots with safety toe, TAP (M2A1) Butyl gloves (M3, M4, or glove set) Undershirt Drawers Socks Mask, slung (M9 or M17 series)	Coveralls or fatigues Safety shoe (if required) Butyl gloves (M3, M4, or glove set)[c] Mask-slung (M9 or M17 series)	Street attire Mask, slung position (M9 or M17 series)
Conditions Required					
Area of spilled agent or liquid contamination Storage operations Sampling operations Material handling Maintenance operations Fire fighting/chemical accident/incident control	Area of suspected agent or agent vapors First entry monitoring of outside storage areas Trained emergency personnel responding to an accident Loading and charging the M9 or M12 decontaminating apparatus	Immediate operating area where suspected contaminated items or equipment are present No contact with contaminated items is required	Immediate area of outside operations where suspected items or equipment are present No contact with contaminated items is required	Worn by observers or supervisors of operation and laboratory personnel	Worn by visitors, casuals, supervisory, or operations control personnel in area where hazardous materials are stored or in clean operating areas

(a)This table presents a brief summary of the data presented in Ref. G-4.

(b)TAP - toxicological agent protective.

(c)Only for operation when GB/VX containers are handled.

container will be placed in condition Code E and scheduled for derusting and repainting if any of the following occur:

1. Minor rust on the ends of the container exceeds 25% of the container surface.

2. Sufficient rust exists in the vicinity of the valves to hinder the detection of agent leakage.

3. Rust or corrosion on the cylindrical surface of the container has progressed to the point of a scaly, granular, or flaked condition, accompanied by definite pitting or etching of the material.

4. Rust or corrosion has progressed to the point where the identification markings on the container are threatened to be rendered illegible.

G.1.2. ONSITE TRANSPORTATION

Transport of munitions on military reservations is, essentially, the movement of these munitions between an interim storage area and the disposal facility. Generally, this movement is characterized by locating a transport vehicle at the loading apron, loading the transport vehicle, traveling to an unloading station, and unloading the vehicle.

Chemical munition movement will take place using either a flatbed munition truck or a munition van. All munitions will be configured in onsite transportation containers (ONCs) or overpacks (spray tanks and weteye bombs) while being transported by truck.

Movement of munitions will take place within the chemical munition exclusion area on existing and/or newly constructed roads. Specific road conditions vary from site to site. At some sites, the roads are essentially flat; at others, the roads are hilly with steep grades. The road surface itself also varies in condition and type. In addition, obstacles such as utility poles are present at some of the reservations, while others have none. The immediate surrounding terrain also varies in each case from sandy and flat to firm clay with ravines.

Equipment to mitigate the effects of a transport accident are present with the munition transporter. This equipment includes fire fighting and decontamination equipment that is fully manned and ready.

G.1.3. HANDLING ACTIVITIES

The following paragraphs describe onsite facility handling activities as they are presently defined for the JACADS facility. Unless another reference is specifically cited these descriptions were taken from the JACADS final design description (Ref. G-10). When it is apparent that differences are required for handling activities at other processing sites, these differences are described. Although the risk analysis did not address specific accident scenarios involving the handling of leakers, normal handling procedures for leaking munitions as described in Ref. G-10 have also been presented.

One condition that may vary from site to site and possibly from igloo to igloo within a site is the relative levels of the pavement inside and outside the entrance to the igloos. Because of differences in floor/ramp level inside and outside the igloo, munitions that are being transported from an igloo are placed on a pad outside the storage igloo to be picked up and loaded onto the transport truck by another forklift. The forklift used outside the igloo may be either electric, gasoline, or LPG powered.

Standard operating procedures exist for continuous monitoring and periodic inspections to identify and isolate leakers of all munition configurations. When preparing for munition removal from an igloo, it is particularly important to identify and isolate leaking munitions so that they may be decontaminated, overpacked, and segregated until processed in a separate campaign. To do this, munitions other than ton containers and spray tanks must be removed from their pallets and handled separately. (Ton containers and spray tanks are always handled singularly.) Normally, no lifting equipment, other than an electric forklift truck, is available for handling single munitions.

When a leaking munition is removed from a pallet, a nonleaking munition of the same configuration and lot number is normally inserted

in place of the leaker to keep the pallets fully populated. In this way there is only one broken pallet in a given munition lot.

Palletized munitions are taken from storage and placed in an ONC for transport to the demilitarization facility by truck. Spray tanks and weteye bombs are contained in overpacks and are loaded directly onto the trucks, without using ONCs.

At the demilitarization facility, munitions arrive in either ONCs or overpacks, either from the MHI or directly from the storage igloo. From the MHI, munitions will be delivered by forklift directly into the elevator and then to the UPA. Munitions coming directly from the storage igloos to the MDB will be transported by a flatbed munition truck or a munition van. On arrival at the MDB, a forklift will be used to unload munitions from the truck and place them in the elevator.

G.1.3.1. Projectiles and Mortars

Each of the 105-mm M60 and M360 cartridges are currently stored in a fiber tube container, with two fiber tube containers per wooden box, and 12 or 15 boxes per pallet. Each 4.2-in. M2/M2A1 mortar cartridge is stored in a fiber tube container, with two fiber tube containers per wooden box, and 24 wooden boxes per pallet.

For the purpose of this study, it was assumed that there will be a special area, separate from the demilitarization facility, where cartridges will be unpacked, the propellant and ignition cartridge removed, and the projectiles repacked in a configuration of 24 munitions per pallet. The mortar propellants which are removed will be placed into 4-in. diameter, 18-in long, thin metallic pipes. The ends of these pipes will be capped with plastic lids. These tubes with propellant and cartridge cases with primers will be fed to the deactivation furnace system (DFS) through the mine and rocket transport conveying system in a separate

campaign. This approach is similar to that for the JACADS plant. However, the U.S. Army is also considering other approaches to be used at the CONUS sites for removal of propellant from these cartridges.

Projectiles are strapped directly to wooden storage/shipping pallets. The pallets contain either twenty-four 105-mm projectiles, eight 155-mm projectiles, or six 8-in. projectiles.

G.1.3.2. Rockets

Each M55 rocket is encased in a fiberglass shipping and firing tube that has aluminum nose and tail closures. Fifteen rocket tubes are strapped onto a wooden storage/shipping pallet.

Rocket pallets are placed in onsite containers (ONC) prior to being transported to the MDB. Each transport truck will carry up to three ONCs with 15 rockets per ONC. The rocket pallets and ONCs are handled inside the storage igloos by electric forklift trucks.

G.1.3.3. Mines

Mines are packed three to a drum along with three M603 fuzes and three M1 activators. Mine pallets (12 drums per pallet) are moved by forklift to the ONC for transport by truck to the MHI. From the MHI, another forklift is used to transfer the ONC into the MDB, and subsequently to the UPA.

G.1.3.4. Bulk Items

MC-1 750-lb bombs are stored two-to-a-pallet while the MK-94 500-lb bombs are not palletized. Ton containers are not palletized in storage. They are moved by forklift but are placed onto the forklift using an M-1 or similar type lifting beam. Spray tanks are stored without pallets in customized containers. For this analysis, it is assumed that spray tanks are normally handled using forklifts.

G.1.4. MUNITIONS DEMILITARIZATION

The onsite disposal option requires that each site have its own demilitarization facility. This eliminates the need for any offsite transportation of agent.

The demilitarization facility at each site will be designed only for processing munitions stored at that site. Nevertheless, the description provided below is generic in order to illustrate all aspects of the demilitarization process.

G.1.4.1. Baseline Technology

The demilitarization facility evaluated in this study is based on the JACADS process. All demilitarization will be performed in the MDB, which houses the UPA, rocket and mine punch-and-drain machines, projectile mortar disassembly machines, rocket and burster shearing machines, mine machine for booster removal, a bulk drain station (BDS) to punch/drain bulk items, agent transfer equipment, a toxic cubicle (TOX) for agent storage tanks, and furnaces for explosive deactivation, agent incineration, metal parts decontamination, and dunnage incineration. All furnaces will have afterburners to ensure complete agent destruction. Each furnace has its own pollution abatement system (PAS).

Revisions to the JACADS design will be necessary for site adaptation (Ref. G-12). Some of the revisions are listed below:

1. Equipment weather enclosures will be added for all process equipment which will be located outdoors, i.e., pollution abatement system (PAS), brine reduction area (BRA), and bulk chemical storage (BCS).

2. All fuel burning equipment, ducts, and fans will be sized for altitude and different fuel, where applicable.

3. Rooms will be resized to provide any additional space necessary to accommodate the changes noted above.

4. The structural design for the building and equipment supports will be evaluated and revised, if required, to meet higher seismic loads.

5. Refrigerated plant air dryers will be changed to desiccant type to prevent water condensation in outdoor piping during winter operations.

A simplified schematic diagram of the process is shown in Fig. G-1. The demilitarization process for each group of munitions is described below (Ref. G-12).

G.1.4.2. <u>Projectiles and Mortars</u>

These munitions (in ONCs) will be examined for leakers in the unloading area. Nonleaking munitions will be unpacked and transferred by elevator to the UPA located on the second floor, where they will be removed from the pallets by personnel wearing Level D protective clothing. They will then be loaded manually on an input tray conveyor, taken to the explosive containment vestibule, and then moved through airlocks and blast gates to the explosive containment room (ECR). All dunnage resulting from the unpacking operation will be burned in the dunnage incinerator.

Inside the ECR, the projectile will be automatically placed on the projectile/mortar disassembly machine (PMD) turntable for removal of explosive components. The burster will then be conveyed to the burster size reduction machine (BSR) and fed by gravity through a discharge chute with double isolation valves into the deactivation furnace system

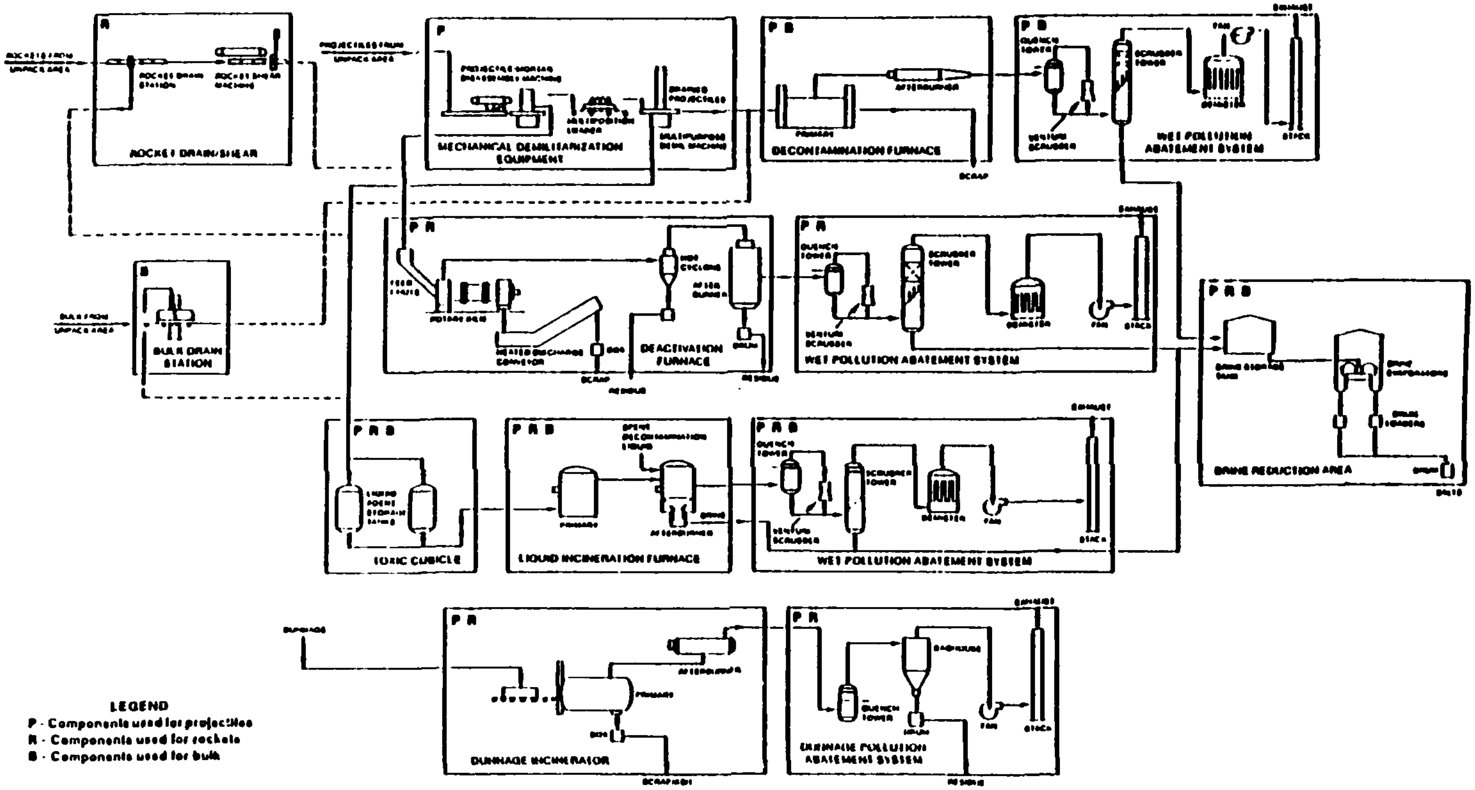

Fig. G-1. Munitions processing flow using JACADS design

(DFS). The fuze will be moved by conveyor to the DFS for incineration. The projectile will be probed to verify burster removal and placed on a conveyor from the ECR and leading to the multipurpose demilitarization machine (MDM) in the munitions processing bay. A pick-and-place robot will pick up a projectile from the pallet and place it on a rotating table. Here, the burster well will be extracted from the projectile and a tube will be inserted into the projectile to remove the liquid agent by suction and convey it to a storage tank in the toxic cubicle. If the burster well is stuck or welded in place, a milling station on the MDM rotating table will cut off the top of the burster well to allow its removal.

Agent collected in the TOX will be incinerated in a liquid incinerator (LIC). The drained projectiles will be placed on a tray and conveyed into the waiting munitions lift car, which descends to the first floor to transfer the tray to a charge car for introduction into the metal parts furnace (MPF). The MPF will thermally decontaminate the drained projectiles to a 5X level.*

G.1.4.3. Rockets

M55 rockets will arrive at the MDB in ONC containers. Only ONCs verified to be free of leaking rockets will be unloaded in the package unloading facility. Operators wearing Level D protective clothing will manually remove individual rockets, feed them through a munition metering system to the explosive containment vestibule (ECV), then into the ECR. The rockets will be automatically punched and drained at the rocket drain station (RDS) in the ECR. Agent will be drained from the rocket by pump suction and collected in the TOX for subsequent incineration in the LIC. Once drained of agent, the punched rockets will be

*The 5X level of decontamination indicates that the material is free of contamination and can be handled without restriction.

conveyed to the rocket shear machine (RSM), which will shear the rockets into the required number of pieces. The separated sections fall by gravity into the feed chute leading to the DFS, which is located on the first floor of the MDB. An interlock will ensure that only one of the two blast gates in the feed chute is open at any given time.

If there are leaking rockets stored in an ONC, it will not be opened in the UPA, but will be conveyed directly to the ECV where operators wearing demilitarization protective ensemble (DPE) suits will open the ONC and manually unload each rocket onto the feed table feeding the conveyor. They will then be processed in the same way as nonleakers.

G.1.4.4. Mines

Pallets of nonleaking mine drums will be removed from the ONCs in the package unloading facility. Mine drums will be unloaded from their pallet in the UPA and placed, unopened, on the drum conveyor entering a mine glove box (MIG) in the ECV. An operator wearing protective clothing will open the drum in the glove box and remove the mines. The activators and fuzes that have been packed in the drums will be placed in a cardboard container and conveyed to the DFS chute. The arming plug will also be removed. A mine will be conveyed into an ECR, where it will be automatically punched and drained of agent. The agent will be drained from the mine by pump suction and pumped to the TOX for subsequent incineration in the LIC.

While in the ECR, the mine will be placed automatically in the mine machine (MIN) to punch out the booster. The mine body and booster are dropped into the DFS.

G.1.4.5. Bulk Items

Bombs, ton containers, and spray tanks in ONCs (or overpacks where appropriate) will be moved from the MHI by forklift, unpacked at the

package unloading facility where an elevator will be used to transfer the munitions to the UPA which is located on the second floor of the JACADS plant. For the bulk only plants, the UPA will be located on the ground floor. A forklift will move the bulk item to the UPA for pallet removal and subsequent transfer to tray assemblies on the input conveyors. Spray tanks will be removed from their shipping containers in the UPA and transferred to tray assemblies on the input conveyor. Unpalletized bulk items, such as ton containers, will be placed directly on tray conveyors. The trays will be conveyed to the bulk drain station (BDS), which is equipped with a large punch and an agent pump and removal tube. The punch will produce a hole in the top of the bulk item, and the removal tube will be inserted through the hole to allow removal of the liquid agent, which will be transferred to the TOX by agent pipe lines.

The tray containing the drained bulk item will be transported to the munitions lift car, which descends to the first floor to discharge the tray to the buffer storage conveyor and into the MPF. Residual agent will be burned in the MPF.

G.1.5. DECOMMISSIONING

After the existing stockpile of lethal chemical agent and munitions at each site has been destroyed, the demilitarization facility will be decommissioned. The activities for cleanup and closure of the destruction facilities, as discussed in Chemical Stockpile Disposal Plan (Ref. G-11), are as follows:

1. Decontamination of the MDB and laboratory.
2. Disposal of all solid wastes and residues.
3. Certification of the plant and site as nontoxic.

The first step in the cleanup operation will be the removal of all equipment not required for the decommissioning effort from the noncontaminated areas of the facility. The contaminated portions of the building and the contaminated destruction equipment will be washed with an aqueous decontamination solution. When the washing operations are complete and the level of decon verified, the surrounding areas will be tested and monitored to verify that any vapor concentrations of agent are within allowable limits. The equipment will be disassembled for thermal decontamination. The building itself will be tested or monitored to verify that any vapor concentrations are within allowable limits.

The furnaces used for decontamination of the munitions will be maintained in place and used for the decontamination of process equipment as long as possible. Final decontamination of the remaining furnace and supporting equipment could be accomplished in a transportable furnace brought to the site.

After all necessary decontamination, disassembly, and demolition, all solid waste and residue resulting from the decommissioning will be disposed of. Materials that cannot be certified for other uses will be

disposed of at approved hazardous waste landfill sites. The decontaminated plant and site will be monitored and tested to ensure that no residual toxic agent is present. After monitoring has been completed and monitoring samples satisfactorily analyzed, the plant will be certified closed.

G.1.6. REFERENCES

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G-10. The R. M. Parsons Company, "JACADS Final Design Description," Task E-2, March 1985.

G-11. "Chemical Stockpile Disposal Plan," U.S. Army Toxic and Hazardous Materials Agency, Draft Report, AMXTH-CD-FR-85047, March 1986.

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APPENDIX H
(Classified Information)

APPENDIX I
TABULATED ACCIDENT SEQUENCE RESULTS

I.1. TABULATED ACCIDENT SEQUENCE RESULTS

The following subsections give the accident sequence results for long-term storage, handling, plant operations, and onsite transport of munitions.

I.1.1. LONG TERM STORAGE

The following tables list the accident results for long term storage for munitions at existing sites.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SL1 - Munition develops a leak during the between-inspections period.																						
SLBGC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.5E-05	1.0E+01	4.5E-04	1.0E+01	1.49E+05	-	-	4.60E+01	90 DAY
SLDHC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-06	1.0E+01	7.0E-06	1.0E+01	N/A	-	6.91E+04	-	-	4.90E+00	90 DAY
SLCGC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.0E-06	1.0E+01	N/A	-	1.46E+04	-	-	1.60E+00	11 DAY
SLCHC	1	2.8E-07	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-06	1.0E+01	N/A	-	N/A	-	2.92E+04	-	-	3.00E+00	90 DAY
SLKGC (IGL)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-04	1.0E+01	N/A	-	2.07E+05	-	-	9.00E+01	90 DAY
SLKHC (60' IGL)	1	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	2.13E+01	90 DAY
SLKHS (OPEN)	1	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-	5.9E-06	1.0E+01	N/A	-	CLASS.	9.00E+01	-	-	90 DAY
SLKHS (OPEN)	1	N/A	-	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	CLASS.	1.00E+00	-	-	1 DAY
SLKHC (WH)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	5.39E+06	-	-	2.13E+01	90 DAY
SLKVC .80 IGL)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-	2.21E+05	-	-	1.82E-01	90 DAY
SLKVC (WH)	1	N/A	-	N/A	-	N/A	-	5.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	1.62E-01	90 DAY
SLMVC	1	9.0E-06	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-06	1.0E+01	N/A	-	2.5E-04	1.0E+01	3.1E-04	1.0E+01	3.86E+04	-	-	NEGL	90 DAY
SLPGC	1	4.9E-06	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01	6.72E+04	-	-	NEGL	90 DAY
SLPHC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	5.0E-06	1.0E+01	8.1E-05	1.0E+01	N/A	-	1.21E+05	-	-	NEGL	90 DAY
SLPVC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01	6.20E+04	-	-	NEGL	90 DAY
SLQGC	1	4.9E-06	1.0E+01	N/A	-	9.3E-06	1.0E+01	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01	6.00E+04	-	-	NEGL	90 DAY
SLQVC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.1E-05	1.0E+01	6.2E-05	1.0E+01	6.00E+04	-	-	NEGL	90 DAY
SLRGC	1	6.1E-05	1.0E+01	N/A	-	4.3E-05	1.0E+01	N/A	-	9.1E-07	1.0E+01	N/A	-	1.3E-03	1.0E+01	1.8E-04	1.0E+01	4.04E+04	-	-	1.07E+01	71 DAY
SLRVC	1	6.1E-05	1.0E+01	N/A	-	4.3E-05	1.0E+01	N/A	-	9.1E-07	1.0E+01	N/A	-	1.3E-03	1.0E+01	1.8E-04	1.0E+01	3.78E+04	-	-	2.70E-02	90 DAY
SLSVC	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-05	1.0E+01	1.36E+04	-	-	NEGL	90 DAY
SLSVC (WH)	1	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-05	1.0E+01	N/A	-	1.83E+05	-	-	NEGL	90 DAY
SL2 - Munition punctured by forklift tine during leaker handling activities.																						
SLBGC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.2E-06	1.3E+01	5.2E-06	1.3E+01	4.40E+02	-	-	4.26E+00	1 HR
SLDHC	2	4.4E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-05	1.3E+01	4.4E-05	1.3E+01	N/A	-	2.88E+02	-	-	1.30E-03	1 HR
SLCGC	2	1.1E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-	4.80E+01	-	-	1.09E-01	1 HR
SLCHC	2	1.1E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-	N/A	-	9.60E+01	-	-	1.30E-03	1 HR
SLKGC	2	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-					

See notes at end of table.

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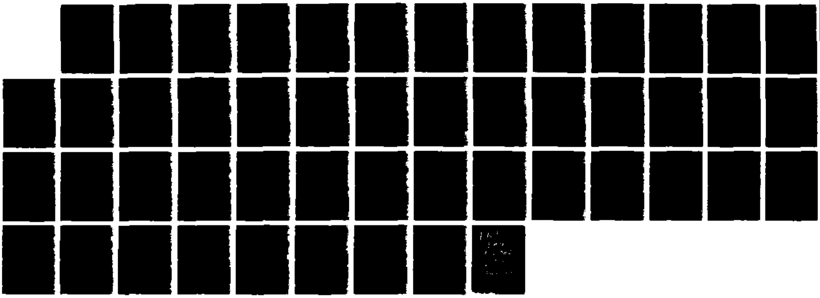
STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

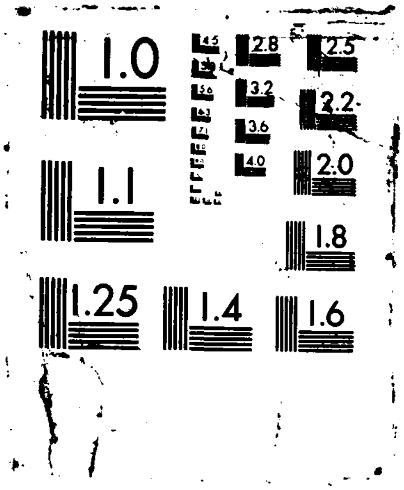
		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLKHC	2	0.0E+00	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	0.0E+00	-					
SLKVC	2	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-					
SLMVC	2	8.5E-05	1.3E+01	N/A	-	N/A	-	N/A	-	8.5E-05	1.3E+01	N/A	-	8.5E-05	1.3E+01	8.5E-05	1.3E+01	0.00E+00	-	-	8.50E-06	1 HR
SLPGC	2	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	5.20E+01	-	-	2.80E-01	1 HR
SLPHC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	N/A	-	9.36E+01	-	-	1.05E-03	1 HR
SLPVC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	4.80E+01	-	-	1.05E-05	1 HR
SLQGC	2	6.0E-05	1.3E+01	N/A	-	6.0E-05	1.3E+01	N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	8.70E+01	-	-	2.80E-01	1 HR
SLGVC	2	N/A	-	N/A		N/A		N/A	-	N/A	-	N/A	-	6.0E-05	1.3E+01	6.0E-05	1.3E+01	8.70E+01	-	-	1.05E-05	1 HR
SLRGC	2	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	3.2E-04	1.3E+01	1.60E+02	-	-	4.46E-01	1 HR
SLRVC	2	3.2E-04	1.3E+01	N/A		3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	N/A	-	3.2E-04	1.3E+01	3.2E-04	1.3E+01	1.50E+02	-	-	1.60E-05	1 HR
SLSVC	2	N/A	-	N/A		N/A	-	N/A	-	N/A	-	N/A	-	4.6E-06	1.3E+01	4.6E-06	1.3E+01	1.36E+03	-	-	1.35E-04	1 HR
SL4 - Large aircraft direct crash onto storage area; fire not contained in 30 minutes (burstered munitions detonate if hit).																						
SLBGF (80 (GL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	1.19E+05	-	-	1.19E+04	1HR
SLBGF 89 (GL)	4	N/A		N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	1.49E+05	-	-	1.49E+04	1HR
SLDHC (60 (GL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.57E+04	-	8.93E+03	1.34E+03	20 MIN
SLDHC (80 (GL)	4	2.2E-10	1.0E+01	N/A		N/A		N/A	-	N/A	-	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	-	4.95E+04	-	1.24E+04	1.86E+03	20 MIN
SLDHC (89 (GL)	4	N/A		N/A		N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	6.91E+04	-	1.73E+04	2.59E+03	20 MIN
SLCGC (60 (GL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.20E+03	-	1.80E+03	5.40E+02	20 MIN
SLCGC (80 (GL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	-	N/A	-	9.79E+03	-	2.45E+03	7.34E+02	20 MIN
SLCGC (89 (GL)	4	N/A	-	N/A		N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	-	N/A	-	1.46E+04	-	3.65E+03	1.09E+03	20 MIN
SLCHC (60 (GL)	4	1.6E-10	1.0E+01	N/A		N/A		N/A		N/A	-	N/A	-	N/A	-	N/A	-	1.44E+04	-	3.60E+03	5.40E+02	20 MIN
SLCHC (80 (GL)	4	2.2E-10	1.0E+01	N/A		N/A	-	N/A		N/A	-	1.6E-09	1.0E+01	N/A	1.0E+01	N/A	-	1.96E+04	-	4.90E+03	7.34E+02	20 MIN
SLCHC (89 (GL)	4	N/A	-	N/A	-	N/A		N/A		N/A	-	N/A	-	N/A	1.0E+01	N/A	-	2.92E+04	-	7.30E+03	1.09E+03	20 MIN
SLHGF (80 (GL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	N/A	-	2.07E+05	-	-	2.07E+04	1HR
SLKHF (60 (GL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	7.31E+03	1HR
SLKHF (OPEN)	4	N/A		1.1E-09	1.0E+01	N/A	-	N/A	-	7.6E-09	1.0E+01	N/A	-	3.5E-09	1.0E+01	N/A	-	CLASS.	-	-	6.80E+04	1HR
SLKHF (NH)	4	N/A	-	N/A	-	N/A		N/A	-	N/A	-	N/A	-	N/A	-	1.1E-08	1.0E+01	5.39E+06	-	-	2.69E+05	1HR
SLKVF (80 (GL)	4	N/A	-	N/A		N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	N/A	-	2.21E+05	-	-	5.52E+03	1HR

See notes at end of table.

AD-A193 354 CHEMICAL STOCKPILE DISPOSAL PROGRAM RISK ANALYSIS OF THE ONSITE DISPOSAL O..(U) GA TECHNOLOGIES INC SAN DIEGO CA A W BARSELL ET AL. AUG 87 GA-C-18562 9/9

UNCLASSIFIED SAPEO-CDE-IS-87010 DAAA15-85-D-0022 F/G 15/6.3 NL

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLKVF (WH)	4	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	7.46E+04	1HR
SLMVC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.72E+04	-	6.80E+03	5.10E+02	20 MIN
SLMVC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	3.86E+04	-	9.64E+03	7.23E+02	20 MIN
SLPGC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.59E+04	-	8.97E+03	2.69E+03	20 MIN
SLPGC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	5.02E+04	-	1.26E+04	3.77E+03	20 MIN
SLPGC (89' IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	6.72E+04	-	1.68E+04	5.04E+03	20 MIN
SLPHC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.46E+04	-	1.61E+04	2.42E+03	20 MIN
SLPHC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	-	9.04E+04	-	2.26E+04	3.39E+03	20 MIN
SLPHC (89' IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	1.21E+05	-	3.02E+04	4.53E+03	20 MIN
SLPVC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.31E+04	-	8.28E+03	6.21E+02	20 MIN
SLPVC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	4.64E+04	-	1.16E+04	8.69E+02	20 MIN
SLPVC (89' IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	6.20E+04	-	1.55E+04	1.16E+03	20 MIN
SLQGC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	8.22E+03	2.47E+03	20 MIN
SLQGC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	4.59E+04	-	1.15E+04	3.45E+03	20 MIN
SLQGC (89' IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	6.00E+04	-	1.50E+04	4.50E+03	20 MIN
SLQVC (60' IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	8.22E+03	6.17E+02	20 MIN
SLQVC (80' IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	4.59E+04	-	1.15E+04	8.61E+02	20 MIN
SLQVC (89' IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	6.00E+04	-	1.50E+04	1.13E+03	20 MIN
SLRGC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.12E+04	-	5.30E+03	1.59E+03	20 MIN
SLRGC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	2.82E+04	-	7.06E+03	2.12E+03	20 MIN
SLRGC (89' IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	4.04E+04	-	1.01E+04	3.03E+03	20 MIN
SLRVC (60' IGL)	4	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.98E+04	-	4.95E+03	3.71E+02	20 MIN
SLRVC (80' IGL)	4	2.2E-10	1.0E+01	N/A	-	N/A	-	N/A	-	4.1E-11	1.0E+01	N/A	-	9.8E-12	1.0E+01	4.1E-10	1.0E+01	2.64E+04	-	6.60E+03	4.95E+02	20 MIN
SLRVC (89' IGL)	4	N/A	-	N/A	-	1.3E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.0E+01	N/A	-	3.78E+04	-	9.45E+03	7.09E+02	20 MIN
SLSVF (80' IGL)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.1E-10	1.0E+01	1.36E+04	-	-	3.39E+02	1HR
SLSVF (WH)	4	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.9E-10	1.0E+01	N/A	-	1.83E+05	-	-	4.58E+03	1HR
SLS - Large aircraft indirect crash onto storage area; fire not contained in 30 minutes (burstered munitions detonate if hit).																						
SLBGF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	1.19E+05	-	-	1.19E+04	1HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLBGF (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	1.49E+05	-	-	1.49E+04	1HR
SLDHC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.57E+04	-	8.93E+03	1.34E+03	20 MIN
SLDHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	2.7E-12	1.3E+01	N/A	-	4.95E+04	-	1.24E+04	1.86E+03	20 MIN
SLDHC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	6.91E+04	-	1.73E+04	2.59E+03	20 MIN
SLCGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.20E+03	-	1.80E+03	5.40E+02	20 MIN
SLCGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	-	N/A	-	9.79E+03	-	2.45E+03	7.34E+02	20 MIN
SLCGC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	-	N/A	-	1.46E+04	-	3.65E+03	1.09E+03	20 MIN
SLCHC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.44E+04	-	3.60E+03	5.40E+02	20 MIN
SLCHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	N/A	1.3E+01	N/A	-	1.96E+04	-	4.90E+03	7.34E+02	20 MIN
SLCHC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.3E+01	N/A	-	2.92E+04	-	7.30E+03	1.09E+03	20 MIN
SLKGF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	2.07E+05	-	-	2.07E+04	1HR
SLKHF (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	7.31E+03	1HR
SLKHF (OPEN)	5	N/A	-	2.1E-09	1.0E+01	N/A	-	N/A	-	7.9E-09	1.0E+01	N/A	-	2.7E-12	1.0E+01	N/A	-	CLASS.	-	-	6.80E+04	1HR
SLKHF (WH)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-08	1.1E+01	5.39E+06	-	-	2.69E+05	1HR
SLKVF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	2.21E+05	-	-	5.52E+03	1HR
SLKVF (WH)	5	N/A	-	N/A	-	N/A	-	3.8E-09	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	7.46E+04	1HR
SLMVC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.72E+04	-	6.80E+03	5.10E+02	20 MIN
SLMVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	3.86E+04	-	9.64E+03	7.23E+02	20 MIN
SLPGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.59E+04	-	8.97E+03	2.69E+03	20 MIN
SLPGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	5.02E+04	-	1.26E+04	3.77E+03	20 MIN
SLPGC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	6.72E+04	-	1.68E+04	5.04E+03	20 MIN
SLPHC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.46E+04	-	1.61E+04	2.42E+03	20 MIN
SLPHC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.4E-10	1.3E+01	2.7E-12	1.3E+01	N/A	-	9.04E+04	-	2.26E+04	3.39E+03	20 MIN
SLPHC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	1.21E+05	-	3.02E+04	4.53E+03	20 MIN
SLPVC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.31E+04	-	8.28E+03	6.21E+02	20 MIN
SLPVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	4.64E+04	-	1.16E+04	8.69E+02	20 MIN
SLPVC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	6.20E+04	-	1.55E+04	1.16E+03	20 MIN
SLQGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	8.22E+03	2.47E+03	20 MIN

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies / Agent Available and Released

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLQGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	4.59E+04	-	1.15E+04	3.45E+03	20 MIN
SLQGC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	6.00E+04	-	1.50E+04	4.50E+03	20 MIN
SLQVC (60' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	8.22E+03	6.17E+02	20 MIN
SLQVC (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	4.59E+04	-	1.15E+04	8.61E+02	20 MIN
SLQVC (89' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	6.00E+04	-	1.50E+04	1.13E+03	20 MIN
SLRGC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.12E+04	-	5.30E+03	1.59E+03	20 MIN
SLRGC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	2.82E+04	-	7.06E+03	2.12E+03	20 MIN
SLRGC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	4.04E+04	-	1.01E+04	3.03E+03	20 MIN
SLRVC (60' IGL)	5	5.7E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.98E+04	-	4.95E+03	3.71E+02	20 MIN
SLRVC (80' IGL)	5	5.9E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.1E-11	1.3E+01	N/A	-	2.7E-12	1.3E+01	1.1E-10	1.3E+01	2.64E+04	-	6.60E+03	4.95E+02	20 MIN
SLRVC (89' IGL)	5	N/A	-	N/A	-	3.4E-11	1.3E+01	N/A	-	N/A	-	N/A	-	2.7E-12	1.3E+01	N/A	-	3.78E+04	-	9.45E+03	7.09E+02	20 MIN
SLSVF (80' IGL)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-10	1.3E+01	1.36E+04	-	-	3.39E+02	1HR
SLSVF (WH)	5	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.0E-10	1.1E+01	N/A	-	1.83E+05	-	-	4.58E+03	1HR
SL6 - Tornado generated missiles strike the storage magazine, warehouse, or open storage area; munitions breached (no detonation).																						
SLBGC	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.5E-15	9.4E+01	1.2E-15	9.4E+01	4.40E+02	-	-	2.56E+01	6 HR
SLDHC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-13	9.4E+01	5.8E-15	9.4E+01	N/A	-	2.88E+02	-	-	1.30E-02	6 HR
SLCGC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	N/A	-	4.80E+01	-	-	1.09E+00	6 HR
SLCHC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-13	9.4E+01	N/A	-	N/A	-	9.60E+01	-	-	1.30E-02	6 HR
SLKGC (80' IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.4E-15	9.4E+01	N/A	-	1.50E+03	-	-	3.71E+01	6 HR
SLKHC (60' IGL)	6	1.2E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.70E+03	-	-	1.44E-01	6 HR
SLKHS (OPEN)	6	N/A	-	6.6E-11	9.4E+01	N/A	-	N/A	-	9.9E-10	9.4E+01	N/A	-	1.2E-12	9.4E+01	N/A	-	1.70E+03	1.70E+03	-	-	6 HR
SLKHC (WH)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.9E-13	9.4E+01	1.70E+03	-	-	1.44E-01	6 HR
SLKVC (80 IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.4E-15	9.4E+01	N/A	-	1.60E+03	-	-	1.60E-03	6 HR
SLKVC (WH)	6	N/A	-	N/A	-	N/A	-	3.3E-10	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.60E+03	-	-	1.60E-03	6 HR
SLMVC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	8.3E-12	9.4E+01	N/A	-	1.3E-14	9.4E+01	5.8E-15	9.4E+01	3.86E+04	-	-	2.30E-04	6 HR
SLPGC	6	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01	6.72E+04	-	-	5.60E+00	6 HR
SLFHC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	3.2E-13	9.4E+01	5.8E-15	9.4E+01	N/A	-	1.21E+05	-	-	2.20E-02	6 HR
SLFVC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.6E-15	9.4E+01	6.20E+04	-	-	2.20E-04	6 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLQGC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01	6.00E+04	-	-	5.60E+00	6 HR
SLQVC	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.8E-15	9.4E+01	5.8E-15	9.4E+01	6.00E+04	-	-	2.20E-04	6 HR
SLRGC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	1.9E-11	9.4E+01	N/A	-	4.8E-14	9.4E+01	5.8E-15	9.4E+01	4.04E+04	-	-	7.53E+00	6 HR
SLRVC	6	4.8E-12	9.4E+01	N/A	-	4.8E-12	9.4E+01	N/A	-	1.9E-11	9.4E+01	N/A	-	4.8E-14	9.4E+01	5.8E-15	9.4E+01	3.78E+04	-	-	2.80E-04	6 HR
SLSVC (80' IGL)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.5E-15	9.4E+01	1.36E+04	-	-	1.60E-03	6 HR
SLSVC (WH)	6	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-13	9.4E+01	N/A	-	1.83E+05	-	-	1.60E-03	6 HR
SL7 - Severe earthquake breaches the munitions in storage igloo; no detonations.																						
SLBGC	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-06	1.3E+01	7.0E-08	1.3E+01	1.49E+05	-	-	2.56E+01	6 HR
SLDHC	7	3.0E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-08	1.3E+01	7.0E-07	1.3E+01	N/A	-	6.91E+04	-	-	7.80E-03	6 HR
SLCGC	7	7.0E-09	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-07	1.3E+01	N/A	-	1.46E+04	-	-	6.53E-01	6 HR
SLCHC	7	7.0E-09	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	7.0E-09	1.3E+01	N/A	-	N/A	-	2.92E+04	-	-	2.07E-03	6 HR
SLKGC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-	2.07E+05	-	-	3.71E+01	6 HR
SLKHC (60' IGL)	7	4.6E-07	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	1.44E-01	6 HR
SLKHS (OPEN)	7	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	CLASS.	-	-	-	-
SLKHC (WH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.39E+06	-	-	-	-
SLKVC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-05	1.3E+01	N/A	-	2.21E+05	-	-	1.60E-03	6 HR
SLKVC (WH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	-	-
SLMVC	7	1.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	1.8E-08	1.3E+01	N/A	-	4.1E-07	1.3E+01	1.8E-08	1.3E+01	3.86E+04	-	-	1.00E-04	6 HR
SLPGC	7	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	6.72E+04	-	-	-	-
SLPHC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	N/A	-	1.21E+05	-	-	-	-
SLPVC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	6.20E+04	-	-	-	-
SLQGC	7	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	6.00E+04	-	-	-	-
SLQVC	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	6.00E+04	-	-	-	-
SLRGC	7	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	2.1E-06	1.3E+01	9.7E-08	1.3E+01	4.04E+04	-	-	2.68E+00	6 HR
SLRVC	7	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	9.7E-08	1.3E+01	N/A	-	2.1E-06	1.3E+01	9.7E-08	1.3E+01	3.78E+04	-	-	1.00E-04	6 HR
SLSVC (80' IGL)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	1.36E+04	-	-	-	-
SLSVC (WH)	7	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.83E+05	-	-	-	-
SL8 - Meteorite strikes the storage area; fire occurs; munitions breached (if burstered detonation occurs)																						

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

SCENARIO	NO.	Accident Frequencies ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	Agent Available and Released AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLBGF	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	1.49E+05	-	-	1.49E+04	1 HR
SLDHC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	N/A	-	6.91E+04	-	1.73E+04	2.59E+03	20 MIN
SLCGC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	1.46E+04	-	3.65E+03	1.09E+03	20 MIN
SLCHC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	2.92E+04	-	7.30E+03	1.09E+03	20 MIN
SLKGF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	2.07E+05	-	-	2.07E+04	1 HR
SLKHF (IGL)	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	7.31E+03	1 HR
SLKHF (OPEN)	8	N/A	-	1.2E-11	1.7E+01	N/A	-	N/A	-	1.2E-11	1.7E+01	N/A	-	1.2E-11	1.7E+01	N/A	-	CLASS.	-	-	6.80E+04	1 HR
SLKHF (WH)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-10	2.6E+01	5.39E+06	-	-	2.69E+05	1 HR
SLKVF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	2.21E+05	-	-	5.52E+03	1 HR
SLKVF (WH)	8	N/A	-	N/A	-	N/A	-	1.0E-09	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	7.46E+04	1 HR
SLMVC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	3.86E+04	-	9.64E+03	7.23E+02	20 MIN
SLPGC	8	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	6.72E+04	-	1.68E+04	5.04E+03	20 MIN
SLPHC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	N/A	-	1.21E+05	-	3.02E+04	4.53E+03	20 MIN
SLPVC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	6.20E+04	-	1.55E+04	1.16E+03	20 MIN
SLQGC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	6.00E+04	-	1.50E+04	4.50E+03	20 MIN
SLQVC	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	6.00E+04	-	1.50E+04	1.13E+03	20 MIN
SLRGC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	4.04E+04	-	1.01E+04	3.03E+03	20 MIN
SLRVC	8	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	N/A	-	6.7E-12	2.6E+01	6.7E-12	2.6E+01	3.78E+04	-	9.45E+03	7.09E+02	20 MIN
SLSVF (IGL)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.7E-12	2.6E+01	1.36E+04	-	-	3.39E+02	1 HR
SLSVF (WH)	8	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-09	2.6E+01	N/A	-	1.83E+05	-	-	4.58E+03	1 HR
SL9 - Munition dropped during leaker isolation activities.																						
SLBGC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.6E-07	1.3E+01	6.6E-07	1.3E+01	4.40E+02	-	-	4.26E+00	1 HR
SLDHC	9	4.5E-07	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	4.5E-07	1.3E+01	4.5E-07	1.3E+01	N/A	-	2.88E+02	-	-	1.30E-03	1 HR
SLCGC	9	9.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-08	1.3E+01	N/A	-	4.80E+01	-	-	1.09E-01	1 HR
SLCHC	9	9.8E-08	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	9.8E-08	1.3E+01	N/A	-	N/A	-	9.60E+01	-	-	1.30E-03	1 HR
SLKGC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	1.50E+03	-	-	6.40E+00	1 HR
SLKHC	9	1.9E-07	1.3E+01	1.9E-07	1.3E+01	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	1.9E-07	1.3E+01	1.9E-07	1.3E+01	1.70E+03	-	-	2.50E-02	1 HR
SLKVC	9	N/A	-	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	N/A	-	1.9E-07	1.3E+01	N/A	-	1.60E+03	-	-	2.70E-04	1 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

SCENARIO	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
		Accident Frequencies																Agent Available and Released				
SLHVC	9	3.6E-07	1.3E+01	N/A	-	N/A	-	N/A	-	3.6E-07	1.3E+01	N/A	-	3.6E-07	1.3E+01	3.6E-07	1.3E+01	3.78E+02	-	-	1.70E-05	1 HR
SLPGC	9	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	5.20E+01	-	-	-	-
SLPHC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	N/A	-	9.36E+01	-	-	-	-
SLPVC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	4.80E+01	-	-	-	-
SLDGC	9	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	8.70E+01	-	-	-	-
SLDVC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	8.70E+01	-	-	-	-
SLRGC	9	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	1.5E-06	1.3E+01	1.60E+02	-	-	4.46E-01	1 HR
SLRVC	9	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	N/A	-	1.5E-06	1.3E+01	1.5E-06	1.3E+01	1.50E+02	-	-	1.60E-05	1 HR
SLSVC	9	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.6E-06	1.3E+01	3.6E-06	1.3E+01	1.36E+03	-	-	2.70E-05	1 HR
SL15 - Small aircraft direct crash onto warehouse or open storage yard; fire not contained in 30 minutes.																						
SLKGF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.07E+05	-	-	-	-
SLKHF (IGL)	15	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	-	-
SLKHF (OPEN)	15	N/A	-	1.6E-05	1.0E+01	N/A	-	N/A	-	5.6E-07	1.0E+01	N/A	-	1.4E-07	1.0E+01	N/A	-	CLASS.	-	-	5.10E+03	30 MIN
SLKHF (WH)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-09	1.0E+01	5.39E+06	-	-	2.69E+05	30 MIN
SLKVF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.21E+05	-	-	-	-
SLKVF (WH)	15	N/A	-	N/A	-	N/A	-	8.1E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	7.46E+04	30 MIN
SLSVF (IGL)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.36E+04	-	-	-	-
SLSVF (WH)	15	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.6E-08	1.0E+01	N/A	-	1.83E+05	-	-	2.03E+03	30 MIN
SL16 - Large aircraft direct crash; no fire. (burstered munitions detonate)																						
SLBGC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	1.19E+05	-	-	5.12E+01	4 HR
SLBGC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	1.49E+05	-	-	5.12E+01	4 HR
SLDHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.57E+04	-	7.14E+02	2.00E-01	4 HR
SLDHC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	-	4.95E+04	-	9.91E+02	2.00E-01	4 HR
SLDHC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	6.91E+04	-	1.38E+03	2.00E-01	4 HR
SLCGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.20E+03	-	1.44E+02	5.12E+01	4 HR
SLCGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	-	N/A	-	9.79E+03	-	1.96E+02	5.12E+01	4 HR
SLCGC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	-	N/A	-	1.46E+04	-	2.92E+02	5.12E+01	4 HR
SLCHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.44E+04	-	2.88E+02	2.00E-01	4 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLCNC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	N/A	1.0E+01	N/A	-	1.96E+04	-	3.92E+02	2.00E-01	4 HR
SLCNC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.0E+01	N/A	-	2.92E+04	-	5.84E+02	2.00E-01	4 HR
SLKGC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	N/A	-	2.07E+05	-	-	5.12E+01	4 HR
SLKHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	2.00E-01	4 HR
SLKHS (OPEN)	16	N/A	-	1.3E-09	1.0E+01	N/A	-	N/A	-	9.4E-09	1.0E+01	N/A	-	4.3E-09	1.0E+01	N/A	-	CLASS.	3.40E+05	-	-	4 HR
SLKHS (HN)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-08	1.0E+01	5.39E+06	3.40E+05	-	-	4 HR
SLKVC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	N/A	-	2.21E+05	-	-	2.16E-03	4 HR
SLKVS (HN)	16	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	3.20E+05	-	-	4 HR
SLMVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.72E+04	-	1.36E+03	2.16E-03	4 HR
SLMVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	3.86E+04	-	1.93E+03	2.16E-03	4 HR
SLPGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.59E+04	-	7.18E+02	5.12E+01	4 HR
SLPGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	5.02E+04	-	1.00E+03	5.12E+01	4 HR
SLPGC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	6.72E+04	-	1.34E+03	5.12E+01	4 HR
SLPHC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.46E+04	-	1.29E+03	2.00E-01	4 HR
SLPHC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	-	9.04E+04	-	1.81E+03	2.00E-01	4 HR
SLPHC (89' IGL)	16	N/A	-	N/A	-	N/A	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	1.21E+05	-	2.42E+03	2.00E-01	4 HR
SLPVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.31E+04	-	6.62E+02	2.16E-03	4 HR
SLPVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	4.64E+04	-	9.27E+02	2.16E-03	4 HR
SLPVC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	6.20E+04	-	1.24E+03	2.16E-03	4 HR
SLQGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	6.58E+02	5.12E+01	4 HR
SLQGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	4.59E+04	-	9.19E+02	5.12E+01	4 HR
SLQGC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	6.00E+04	-	1.20E+03	5.12E+01	4 HR
SLQVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	6.58E+02	2.16E-03	4 HR
SLQVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	4.59E+04	-	9.19E+02	2.16E-03	4 HR
SLQVC (89' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	6.00E+04	-	1.20E+03	2.16E-03	4 HR
SLRGC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.12E+04	-	1.06E+03	5.12E+01	4 HR
SLRGC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	2.82E+04	-	1.41E+03	5.12E+01	4 HR
SLRGC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	4.04E+04	-	2.02E+03	5.12E+01	4 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLRVC (60' IGL)	16	2.0E-10	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.98E+04	-	9.90E+02	2.16E-03	4 HR
SLRVC (80' IGL)	16	2.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	5.0E-11	1.0E+01	N/A	-	1.2E-11	1.0E+01	5.0E-10	1.0E+01	2.64E+04	-	1.32E+03	2.16E-03	4 HR
SLRVC (89' IGL)	16	N/A	-	N/A	-	1.6E-10	1.0E+01	N/A	-	N/A	-	N/A	-	1.3E-11	1.0E+01	N/A	-	3.78E+04	-	1.89E+03	2.16E-03	4 HR
SLSVC (80' IGL)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	5.0E-10	1.0E+01	1.36E+04	-	-	2.16E-03	4 HR
SLSVS (WH)	16	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.8E-10	1.0E+01	N/A	-	1.83E+05	2.71E+05	-	-	4 HR
SL17 - large aircraft direct crash; fire contained within 30 minutes. (Applies to non-burstered munitions only)																						
SLXHF (OPEN)	17	N/A	-	3.7E-13	1.0E+01	N/A	-	N/A	-	2.6E-12	1.0E+01	N/A	-	1.2E-12	1.0E+01	N/A	-	CLASS.	-	-	1.70E+04	30 MIN
SLXHF (WH)	17	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.8E-12	1.0E+01	5.39E+06	-	-	1.70E+04	30 MIN
SLXVF (WH)	17	N/A	-	N/A	-	N/A	-	5.6E-13	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	8.00E+03	30 MIN
SLSVF (WH)	17	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.3E-13	1.0E+01	N/A	-	1.83E+05	-	-	6.78E+03	30 MIN
SL18 - Small aircraft direct crash onto warehouse or open storage yard; no fire.																						
SLXHS (OPEN)	18	N/A	-	2.0E-05	1.0E+01	N/A	-	N/A	-	6.9E-07	1.0E+01	N/A	-	1.7E-07	1.0E+01	N/A	-	CLASS.	2.55E+04	-	-	4 HR
SLXHS (WH)	18	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.1E-08	1.0E+01	5.39E+06	2.55E+04	-	-	4 HR
SLXVS (WH)	18	N/A	-	N/A	-	N/A	-	1.0E-08	1.0E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	2.40E+04	-	-	4 HR
SLSVS (WH)	18	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.9E-08	1.0E+01	N/A	-	1.83E+05	2.03E+04	-	-	4 HR
SL19 - Small aircraft direct crash onto warehouse or open storage yard; fire contained in 30 minutes.																						
SLXHF (OPEN)	19	N/A	-	3.0E-07	1.3E+01	N/A	-	N/A	-	1.1E-08	1.3E+01	N/A	-	2.7E-09	1.3E+01	N/A	-	CLASS.	-	-	1.28E+03	30 MIN
SLXHF (WH)	19	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-10	1.3E+01	5.39E+06	-	-	1.28E+03	30 MIN
SLXVF (WH)	19	N/A	-	N/A	-	N/A	-	1.5E-10	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	6.00E+02	30 MIN
SLSVF (WH)	19	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.0E-10	1.3E+01	N/A	-	1.83E+05	-	-	5.09E+02	30 MIN
SL20 - Large aircraft indirect crash onto storage area; no fire.																						
SLRGC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	1.19E+05	-	-	1.38E+02	4 HR
SLBGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	1.49E+05	-	-	1.73E+02	4 HR
SLDHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.57E+04	-	6.00E+00	3.10E-02	4 HR
SLDHC (80 IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	3.3E-12	1.3E+01	N/A	-	4.95E+04	-	6.00E+00	4.29E-02	4 HR
SLDHC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	6.91E+04	-	6.00E+00	5.99E-02	4 HR
SLCGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.20E+03	-	1.60E+00	1.96E+00	4 HR
SLCGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	-	N/A	-	9.79E+03	-	1.60E+00	2.67E+00	4 HR

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released					
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLCGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	-	N/A	-	1.46E+04	-	1.60E+00	3.98E+00	4 HR
SLCHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.44E+04	-	3.20E+00	2.34E-02	4 HR
SLCHC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	N/A	1.3E+01	N/A	-	1.96E+04	-	3.20E+00	3.18E-02	4 HR
SLCHC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	1.3E+01	N/A	-	2.92E+04	-	3.20E+00	4.74E-02	4 HR
SLKGC (80 IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	N/A	-	2.07E+05	-	-	5.30E+01	4 HR
SLKHC (60 IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	1.29E-01	4 HR
SLKHS (OPEN)	20	N/A	-	2.6E-09	1.0E+01	N/A	-	N/A	-	9.7E-09	1.0E+01	N/A	-	3.5E-09	1.0E+01	N/A	-	CLASS.	6.80E+04	-	-	4 HR
SLKHC (WH)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-08	1.1E+01	5.39E+06	-	-	2.00E+00	4 HR
SLKVC (80 IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	N/A	-	2.21E+05	-	-	2.24E-03	4 HR
SLKVC (WH)	20	N/A	-	N/A	-	N/A	-	4.7E-09	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	2.16E-02	4 HR
SLMVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.72E+04	-	1.05E+01	8.81E-04	4 HR
SLMVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	3.86E+04	-	1.05E+01	1.25E-03	4 HR
SLFGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.59E+04	-	6.50E+00	1.24E+01	4 HR
SLFGC (80 IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	5.02E+04	-	6.50E+00	1.73E+01	4 HR
SLPGC (89' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	6.72E+04	-	6.50E+00	2.32E+01	4 HR
SLPHC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	6.46E+04	-	1.17E+01	4.64E-02	4 HR
SLPHC (80 IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	5.4E-10	1.3E+01	3.3E-12	1.3E+01	N/A	-	9.04E+04	-	1.17E+01	6.49E-02	4 HR
SLPHC (39' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	1.21E+05	-	1.17E+01	8.68E-02	4 HR
SLFVC (60 IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.31E+04	-	6.00E+00	4.64E-04	4 HR
SLPVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	4.64E+04	-	6.00E+00	6.49E-04	4 HR
SLPVC (59' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	6.20E+04	-	6.00E+00	8.68E-04	4 HR
SLQGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	1.45E+01	5.08E+00	4 HR
SLQGC (60' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	4.59E+04	-	1.45E+01	7.10E+00	4 HR
SLQGC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	6.00E+04	-	1.45E+01	9.27E+00	4 HR
SLQVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.29E+04	-	1.45E+01	1.91E-04	4 HR
SLQVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	4.59E+04	-	1.45E+01	2.66E-04	4 HR
SLQVC (89 IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	6.00E+04	-	1.45E+01	3.48E-04	4 HR
SLRGC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.12E+04	-	1.07E+01	1.77E+01	4 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

Accident Frequencies | Agent Available and Released

SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLGGC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	2.82E+04	-	1.07E+01	2.35E+01	4 HR
SLRGC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	4.04E+04	-	1.07E+01	3.37E+01	4 HR
SLRVC (60' IGL)	20	7.0E-11	1.3E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.98E+04	-	1.00E+01	6.34E-04	4 HR
SLRVC (80' IGL)	20	7.3E-11	1.3E+01	N/A	-	N/A	-	N/A	-	1.4E-11	1.3E+01	N/A	-	3.3E-12	1.3E+01	1.4E-10	1.3E+01	2.64E+04	-	1.00E+01	8.45E-04	4 HR
SLRVC (89' IGL)	20	N/A	-	N/A	-	4.2E-11	1.3E+01	N/A	-	N/A	-	N/A	-	3.4E-12	1.3E+01	N/A	-	3.78E+04	-	1.00E+01	1.21E-03	4 HR
SLSVC (80' IGL)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-10	1.3E+01	1.36E+04	-	-	1.62E-04	4 HR
SLSVC (WH)	20	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.4E-10	1.1E+01	N/A	-	1.83E+05	-	-	2.16E-02	4 HR
SL21 - large aircraft indirect crash onto storage area; fire contained in 30 minutes																						
SLBGF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	-	0.0E+00	-	1.19E+05	-	-	3.56E+02	30 MIN
SLBGF (89' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.3E-16	-	N/A	-	1.49E+05	-	-	4.46E+02	30 MIN
SLKGF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	-	N/A	-	2.07E+05	-	-	6.21E+02	30 MIN
SLKHF (60' IGL)	21	1.9E-14	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	2.19E+02	30 MIN
SLKHF (OPEN)	21	N/A	-	7.2E-13	1.0E+01	N/A	-	N/A	-	2.7E-12	1.0E+01	N/A	-	9.7E-13	1.0E+01	N/A	-	CLASS.	-	-	6.80E+04	30 MIN
SLKHF (WH)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	4.8E-12	1.1E+01	5.39E+06	-	-	6.80E+04	30 MIN
SLKVF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	9.2E-16	1.3E+01	N/A	-	2.21E+05	-	-	1.66E+02	30 MIN
SLKVF (WH)	21	N/A	-	N/A	-	N/A	-	1.3E-12	1.1E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	1.28E+05	30 MIN
SLSVF (80' IGL)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	1.36E+04	-	-	1.02E+01	30 MIN
SLSVF (WH)	21	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	2.1E-13	1.1E+01	N/A	-	1.83E+05	-	-	5.42E+04	30 MIN
SL22 - Severe earthquake leads to munition detonation																						
SLBGC	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	1.49E+05	-	-	-	-
SLDHC	22	1.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.2E-08	2.6E+01	2.7E-07	2.6E+01	N/A	-	6.91E+04	--	6.00E+00	6.50E-03	6 HR
SLCGC	22	6.2E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.4E-07	2.6E+01	N/A	-	1.46E+04	--	1.60E+00	5.45E-01	6 HR
SLCHC	22	6.2E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	6.2E-07	2.6E+01	N/A	-	N/A	-	2.92E+04	--	3.20E+00	6.50E-03	6 HR
SLKGS (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.07E+05	--	-	-	-
SLKHS (IGL)	22	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	--	-	-	-
SLKHS (OPEN)	22	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	CLASS.	--	-	-	-
SLKHS (WH)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	5.39E+06	--	-	-	-
SLKVS (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.21E+05	--	-	-	-

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLKVS (WH)	22	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	--	-	-	-
SLMVC	22	7.0E-09	2.6E+01	N/A	-	N/A	-	N/A	-	7.0E-09	2.6E+01	N/A	-	1.6E-07	2.6E+01	7.0E-09	2.6E+01	3.86E+04	--	3.15E+01	2.55E-04	6 HR
SLPGC	22	4.7E-09	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.0E-07	2.6E+01	4.7E-09	2.6E+01	6.72E+04	--	6.50E+00	2.80E+00	6 HR
SLPHC	22	4.7E-09	2.6E+01	N/A	-	4.7E-09	2.6E+01	N/A	-	N/A	-	4.7E-09	2.6E+01	1.0E-07	2.6E+01	N/A	-	1.21E+05	--	1.17E+01	1.05E-02	6 HR
SLPVC	22	4.7E-09	2.6E+01	N/A	-	4.7E-09	2.6E+01	N/A	-	N/A	-	N/A	-	1.0E-07	2.6E+01	4.7E-09	2.6E+01	6.20E+04	--	6.00E+00	1.05E-04	6 HR
SLQGC	22	3.4E-09	2.6E+01	N/A	-	3.4E-09	2.6E+01	N/A	-	N/A	-	N/A	-	7.6E-08	2.6E+01	3.4E-09	2.6E+01	6.00E+04	--	1.45E+01	2.80E+00	6 HR
SLQVC	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	7.6E-08	2.6E+01	3.4E-09	2.6E+01	6.00E+04	--	1.45E+01	1.05E-04	6 HR
SLRGC	22	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	8.9E-08	2.6E+01	3.9E-09	2.6E+01	4.04E+04	--	2.14E+01	5.80E+00	6 HR
SLRVC	22	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	3.9E-09	2.6E+01	N/A	-	8.9E-08	2.6E+01	3.9E-09	2.6E+01	3.78E+04	--	2.00E+01	2.08E-04	6 HR
SLSVF (IGL)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	1.36E+04	-	-	-	-
SLSVF (WH)	22	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	1.83E+05	-	-	-	-
SL23 - Tornado generated missiles strike the storage igloo and cause munition detonation.																						
SLBGS	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	1.49E+05	-	-	-	-
SLDHC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.2E-14	9.9E+01	3.2E-16	9.9E+01	N/A	-	6.91E+04	-	6.00E+00	6.50E-03	6 HR
SLCGC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	N/A	-	1.46E+04	-	1.60E+00	5.45E-01	6 HR
SLCHC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	2.2E-14	9.9E+01	N/A	-	N/A	-	2.92E+04	-	3.20E+00	6.50E-03	6 HR
SLKGS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.07E+05	-	-	-	-
SLKHS (IGL)	23	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	1.46E+05	-	-	-	-
SLKHS (OPEN)	23	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	0.0E+00	-	N/A	-	CLASS.	-	-	-	-
SLKHS (WH)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	5.39E+06	-	-	-	-
SLKVS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	2.21E+05	-	-	-	-
SLKVS (WH)	23	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	2.99E+06	-	-	-	-
SLMVC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	4.6E-13	9.9E+01	N/A	-	7.4E-16	9.9E+01	4.0E-16	9.9E+01	3.86E+04	-	3.15E+01	2.55E-04	6 HR
SLPGC	23	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01	6.72E+04	-	6.50E+00	2.80E+00	6 HR
SLPHC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	2.2E-14	9.9E+01	3.2E-16	9.9E+01	N/A	-	1.21E+05	-	1.17E+01	1.05E-02	6 HR
SLPVC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01	6.20E+04	-	6.00E+00	1.05E-04	6 HR
SLQGC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01	6.00E+04	-	1.45E+01	2.80E+00	6 HR
SLQVC	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-16	9.9E+01	4.0E-16	9.9E+01	6.00E+04	-	1.45E+01	1.05E-04	6 HR

See notes at end of table.

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STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLRGC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	1.1E-12	9.9E+01	N/A	-	2.6E-15	9.9E+01	4.0E-16	9.9E+01	1.04E+04	-	2.14E+01	5.80E+00	6 HR
SLRVC	23	3.4E-13	9.9E+01	N/A	-	3.4E-13	9.9E+01	N/A	-	1.1E-12	9.9E+01	N/A	-	2.6E-15	9.9E+01	4.0E-16	9.9E+01	3.78E+04	-	2.00E+01	2.08E-04	6 HR
SLSVS (IGL)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	1.36E+04	-	-	-	-
SLSVS (MH)	23	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	1.83E+05	-	-	-	-
SL24 - Lightning strikes ton containers stored outdoors.																						
SLHS (OPEN)	24	N/A	-	1.4E-10	1.0E+01	N/A	-	N/A	-	5.1E-10	1.0E+01	N/A	-	1.4E-10	1.0E+01	N/A	-	1.70E+03	1.70E+03	-	-	2 HR
SL25 - Munitions dropped during leaker isolation; munition detonates.																						
SLBGC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	4.40E+02	-	-	-	-
SLDHC	25	1.7E-07	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	1.7E-07	2.6E+01	1.7E-07	2.6E+01	N/A	-	2.88E+02	-	6.00E+00	6.50E-03	2 HR
SLCGC	25	8.9E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-08	2.6E+01	N/A	-	4.80E+01	-	1.60E+00	5.45E-01	2 HR
SLCHC	25	8.9E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	8.9E-08	2.6E+01	N/A	-	N/A	-	9.60E+01	-	3.20E+00	6.50E-03	2 HR
SLKGC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	1.50E+03	-	-	-	-
SLKHC	25	0.0E+00	-	0.0E+00	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	1.70E+03	-	-	-	-
SLKVC	25	N/A	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	N/A	-	0.0E+00	-	N/A	-	1.60E+03	-	-	-	-
SLMVC	25	1.3E-07	2.6E+01	N/A	-	N/A	-	N/A	-	1.3E-07	2.6E+01	N/A	-	1.3E-07	2.6E+01	1.3E-07	2.6E+01	3.78E+02	-	3.15E+01	2.55E-04	2 HR
SLPGC	25	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	5.20E+01	-	6.50E+00	2.80E+00	2 HR
SLPHC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	N/A	-	9.36E+01	-	1.17E+01	1.05E-02	2 HR
SLPVC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	4.80E+01	-	6.00E+00	1.05E-04	2 HR
SLQGC	25	3.2E-08	2.6E+01	N/A	-	3.2E-08	2.6E+01	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	8.70E+01	-	1.45E+01	2.80E+00	2 HR
SLQVC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	3.2E-08	2.6E+01	3.2E-08	2.6E+01	8.70E+01	-	1.45E+01	1.05E-04	2 HR
SLRGC	25	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	5.7E-08	2.6E+01	1.60E+02	-	2.14E+01	5.80E+00	2 HR
SLRVC	25	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	N/A	-	5.7E-08	2.6E+01	5.7E-08	2.6E+01	1.50E+02	-	2.00E+01	2.08E-04	2 HR
SLSVC	25	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	N/A	-	0.0E+00	-	0.0E+00	-	1.36E+03	-	-	-	-

NOTES:

See notes at end of table.

STORAGE ACCIDENTS - (Frequency units given at bottom of table)
FOR MUNITIONS AT EXISTING SITES

		Accident Frequencies																Agent Available and Released				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME

1. Frequency units for scenario 1 are events per munition year.

2. Frequency units for scenarios 2, 9, and 25 are events per leaker.

3. Frequency units for scenarios 4, 5, 8, 15 through 21, and 23 are events per storage unit-year (igloo or warehouse). For ton containers stored outdoors, frequency units for scenarios 8 and 24 are events per cluster-year of ton containers (15 TC/cluster).

4. Agent release for SLKHS 1 (open) assumes outdoor spill onto a porous surface.

5. Frequency units for scenarios 7 and 22 are events per year.

See notes at end of table.

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STORAGE EARTHQUAKE - WAREHOUSES

STORAGE - EARTHQUAKE-INDUCED ACCIDENTS IN THE WAREHOUSES
(PER YEAR)

		ACCIDENT FREQUENCIES																AGENT AVAILABLE AND RELEASED				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLKVF	261	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-06	1.0E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.0E+06	-	-	7.5E+04	6 HR
SLKVC	262	N/A	N/A	N/A	N/A	N/A	N/A	9.5E-07	2.0E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.0E+06	-	-	NEGL	6 HR
SLKVF	263	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-09	2.9E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.0E+06	-	-	2.0E+02	6 HR
SLKVF	264	N/A	N/A	N/A	N/A	N/A	N/A	3.3E-04	5.5E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.0E+06	-	-	7.5E+04	6 HR
SLKVC	265	N/A	N/A	N/A	N/A	N/A	N/A	1.4E-04	8.6E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.0E+06	-	-	NEGL	6 HR
SLSVF	271	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.7E-04	8.6E+00	N/A	N/A	1.8E+05	-	-	4.5E+03	6 HR
SLSVF	272	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.3E-06	7.1E+00	N/A	N/A	1.8E+05	-	-	4.5E+03	6 HR
SLSVF	273	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-05	9.3E+00	N/A	N/A	3.6E+05	-	-	9.0E+03	6 HR
SLSVF	274	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9E-06	1.1E+01	N/A	N/A	1.8E+05	-	-	4.5E+03	6 HR
SLSVF	275	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.0E-07	3.4E+01	N/A	N/A	1.8E+05	-	-	4.5E+03	6 HR
SLSVF	276	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.8E-08	2.9E+01	N/A	N/A	3.6E+05	-	-	9.0E+03	6 HR
SLKHF	281	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.9E-07	1.3E+01	5.4E+06	-	-	2.7E+05	6 HR
SLKHF	282	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.3E-05	8.8E+00	5.4E+06	-	-	5.4E+05	6 HR
SLKHF	283	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9E-07	1.8E+01	1.1E+07	-	-	NEGL	6 HR
SLKHC	284	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-10	3.1E+01	5.4E+06	-	-	2.7E+05	6 HR
SLKHF	285	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1E-10	3.1E+01	5.4E+06	-	-	2.7E+05	6 HR
SLKHF	286	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL		5.4E+06	-	-	5.4E+05	6 HR
SLKHF	287	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.5E-10	5.8E+01	1.1E+07	-	-	NEGL	6 HR
SLKHC	288	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL		5.4E+06	-	-	2.7E+05	-
SLKHF	289	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NEGL		5.4E+06	-	-	5.4E+05	-
SLKHF	2810	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.4E-05	1.3E+01	5.4E+06	-	-	NEGL	6 HR
SLKHF	2811	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.9E-05	7.5E+00	1.1E+07	-	-	2.7E+05	6 HR
SLKHF	2812	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.2E-07	9.2E+00	5.4E+06	-	-	5.4E+05	6 HR
SLKHF	2813	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.6E-08	2.3E+01	5.4E+06	-	-	NEGL	6 HR
SLKHF	2814	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.9E-08	2.7E+01	5.4E+06	-	-	2.7E+05	6 HR

STORAGE EARTHQUAKE - WAREHOUSES

STORAGE - EARTHQUAKE-INDUCED ACCIDENTS IN THE WAREHOUSES
(PER YEAR)

		ACCIDENT FREQUENCIES																	AGENT AVAILABLE AND RELEASED				
SCENARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL.	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
SLKHF	2815	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.6E-10	2.7E+01	5.4E+06	-	-	5.4E+05	6 HR
SLKHF	2816	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.6E-05	5.2E+00	5.4E+06	-	-	NEGL	6 HR
SLKHF	2817	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1E-05	9.8E+00	1.1E+07	-	-	5.4E+05	6 HR

I.1.2. HANDLING

The following tables list the accident results for handling of munitions.

FREE : DATE 20-Aug-87

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
		Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container)																Agent Available and Released				
HFBGS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.2E-09	1.3E+01	4.2E-09	--	440.0	220.0	--	--	1hr
HFDHS	1	4.2E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.2E-09	1.3E+01	4.2E-09	1.3E+01	0.0E+00	--	288.0	6.0	--	--	1hr
HFCGS	1	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.8E-10	1.3E+01	0.0E+00	--	48.0	1.6	--	--	1hr
HFCHS	1	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.8E-10	1.3E+01	0.0E+00	--	0.0E+00	--	96.0	3.2	--	--	1hr
HFKGS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--	1500.0	1500.0	--	--	1hr
HFKHS	1	8.6E-09	1.3E+01	8.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	6.6E-09	1.3E+01	0.0E+00	--	8.6E-09	1.3E+01	8.6E-09	1.3E+01	1700.0	1700.0	--	--	1hr
HFKVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	8.6E-09	1.3E+01	0.0E+00	--	1600.0	1600.0	--	--	1hr
HFMVS	1	5.8E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.8E-09	1.3E+01	0.0E+00	--	5.8E-09	1.3E+01	5.8E-09	1.3E+01	378.0	10.5	--	--	1hr
HFPGS	1	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	52.0	6.5	--	--	1hr
HFPHS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	0.0E+00	--	93.6	11.7	--	--	1hr
HFPVS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	48.0	6.0	--	--	1hr
HFQGS	1	7.2E-10	1.3E+01	0.0E+00	--	7.2E-10	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	87.0	14.5	--	--	1hr
HFQVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-10	1.3E+01	7.2E-10	1.3E+01	87.0	14.5	--	--	1hr
HFRGS	1	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01	160.5	10.7	--	--	1hr
HFRVS	1	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	0.0E+00	--	3.2E-09	1.3E+01	3.2E-09	1.3E+01	150.0	10.0	--	--	1hr
HFSVS	1	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-06	1.3E+01	1.0E-06	1.3E+01	1356.0	1356.0	--	--	1hr
HFBGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-16	3.1E+01	1.0E-16	3.1E+01	220.0	--	--	NEGL	--
HFDHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0	--	--	--	--
HFCGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.6	--	--	--	--
HFCHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.2	--	--	--	--
HFKGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	1500.0	--	--	NEGL	--
HFKHC	2	8.4E-16	3.1E+01	8.4E-16	3.1E+01	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	8.4E-16	3.1E+01	8.4E-16	3.1E+01	1700.0	--	--	NEGL	--
HFKVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	0.0E+00	--	8.4E-16	3.1E+01	0.0E+00	--	1600.0	--	--	NEGL	--
HFMVC	2	2.6E-17	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.6E-17	3.1E+01	0.0E+00	--	2.6E-17	3.1E+01	2.6E-17	3.1E+01	10.5	--	--	NEGL	--
HFPGC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.5	--	--	--	--
HFPHC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	11.7	--	--	--	--
HFPVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0	--	--	--	--
HFQGS	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	14.5	--	--	--	--
HFQVS	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	14.5	--	--	--	--
HFRGC	2	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	1.8E-16	3.1E+01	10.7	--	--	NEGL	--
HFRVC	2	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	0.0E+00	--	1.8E-16	3.1E+01	1.8E-16	3.1E+01	10.0	--	--	NEGL	--
HFSVC	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.5E-15	3.1E+01	4.5E-15	3.1E+01	1356.0	--	--	NEGL	--

PAGE 2 DATE 20-Aug-87

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container) — *Agent Available and Released*

	SCENARIO NUMBER	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
HFBGF	2	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.1E-11	3.1E+01	3.1E-11	3.1E+01	440.0	--	--	2.20E+01	10min
HFDHF	3	9.4E-11	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.4E-11	3.1E+01	9.4E-11	3.1E+01	0.0E+00	--	288.0	--	--	3.00E-01	10min
HFCGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	46.0	--	--	--	--
HFCHF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	96.0	--	--	--	--
HFKGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	1500.0	--	--	1.50E+02	10min
HFKHF	3	1.0E-10	3.1E+01	1.0E-10	3.1E+01	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	1.0E-10	3.1E+01	1.0E-10	3.1E+01	1700.0	--	--	8.50E+01	10min
HFKVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	0.0E+00	--	1.0E-10	3.1E+01	0.0E+00	--	1600.0	--	--	4.00E+01	10min
HFMVF	3	1.4E-10	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-10	3.1E+01	0.0E+00	--	1.4E-10	3.1E+01	1.4E-10	3.1E+01	378.0	--	--	2.63E-01	10min
HFPGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	52.0	--	--	--	--
HFPHF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	93.6	--	--	--	--
HFPVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	--	--
HFQGF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFQVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFRGF	3	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	8.1E-11	3.1E+01	160.5	--	--	1.07E+00	10min
HFRVF	3	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	0.0E+00	--	8.1E-11	3.1E+01	8.1E-11	3.1E+01	150.0	--	--	2.50E-01	10min
HFSVF	3	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.0E-09	3.1E+01	2.0E-09	3.1E+01	1356.0	--	--	3.39E+01	10min
HFSVS	4	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.1E-07	1.3E+01	3.1E-07		1356.0	--	--	9.00E-05	1hr
HFBGF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	288.0	--	--	--	--
HFDHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	288.0	--	--	--	--
HFCGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	--	--
HFCHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	96.0	--	--	--	--
HFKGF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1500.0	--	--	--	--
HFKHF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1700.0	--	--	--	--
HFKVF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1600.0	--	--	--	--
HFMVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	378.0	--	--	--	--
HFPGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	52.0	--	--	--	--
HFPHC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	93.6	--	--	--	--
HFPVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	--	--
HFQGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFQVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFRGC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	160.5	--	--	--	--
HFRVC	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	150.0	--	--	--	--

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container) — Agent Available and Released

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
HFSVF	5	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1356.0	--	--	--	--
HFBGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	8.3E-10	1.3E+01	8.3E-10	1.3E+01	440.0	220.0	--	--	1hr
HFDHS	7	2.5E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.5E-09	1.3E+01	2.5E-09	1.3E+01	0.0E+00	--	288.0	6.0	--	--	1hr
HFCGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	--	--
HFCHS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	96.0	--	--	--	--
HFKGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	1500.0	1500.0	--	--	1hr
HFKHS	7	2.7E-09	1.3E+01	2.7E-09	1.3E+01	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	2.7E-09	1.3E+01	2.7E-09	1.3E+01	1700.0	1700.0	--	--	1hr
HFKVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	0.0E+00	--	2.7E-09	1.3E+01	0.0E+00	--	1600.0	1600.0	--	--	1hr
HFMVS	7	3.6E-09	1.3E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-09	1.3E+01	0.0E+00	--	3.6E-09	1.3E+01	3.6E-09	1.3E+01	378.0	10.5	--	--	1hr
HFFGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	52.0	--	--	--	--
HFPHS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	93.6	--	--	--	--
HFPVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	--	--
HFGGS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFQVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	--	--
HFRGS	7	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	2.2E-09	1.3E+01	160.5	10.7	--	--	1hr
HFRVS	7	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	0.0E+00	--	2.2E-09	1.3E+01	2.2E-09	1.3E+01	150.0	10.0	--	--	1hr
HFSVS	7	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.2E-08	1.3E+01	5.2E-08	1.3E+01	1356.0	1356.0	--	--	1hr
HFBGC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.3E-18	3.1E+01	5.3E-18	3.1E+01	220.0	--	--	NEGL	--
HFDHC	8	5.3E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.3E-18	3.1E+01	5.3E-18	3.1E+01	0.0E+00	--	6.0	--	--	NEGL	--
HFCGC	8	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0E-19	3.1E+01	0.0E+00	--	1.6	--	--	NEGL	--
HFCHC	8	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	3.2	--	--	NEGL	--
HFKGC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	1500.0	--	--	NEGL	--
HFKHC	8	1.1E-17	3.1E+01	1.1E-17	3.1E+01	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	1.1E-17	3.1E+01	1.1E-17	3.1E+01	1700.0	--	--	NEGL	--
HFKVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	0.0E+00	--	1.1E-17	3.1E+01	0.0E+00	--	1600.0	--	--	NEGL	--
HFMVC	8	7.2E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-18	3.1E+01	0.0E+00	--	7.2E-18	3.1E+01	7.2E-18	3.1E+01	10.5	--	--	NEGL	--
HFPGC	8	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	6.5	--	--	NEGL	--
HFFHC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	0.0E+00	--	11.7	--	--	NEGL	--
HFPVC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	6.0	--	--	NEGL	--
HFGGC	8	9.0E-19	3.1E+01	0.0E+00	--	9.0E-19	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	14.5	--	--	NEGL	--
HFQVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-19	3.1E+01	9.0E-19	3.1E+01	14.5	--	--	NEGL	--
HFRGC	8	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	4.1E-18	3.1E+01	10.7	--	--	NEGL	--
HFRVC	8	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	0.0E+00	--	4.1E-18	3.1E+01	4.1E-18	3.1E+01	10.0	--	--	NEGL	--

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container) — Agent Available and Released

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
HFSVC	8	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-15	3.1E+01	1.2E-15	3.1E+01	1356.0	--	--	NEGL	--
HFSVC	9	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.7E-16	3.1E+01	7.7E-16	3.1E+01	1356.0	--	--	1.35E-04	1hr
HFBGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.3E-19	3.1E+01	4.3E-19	3.1E+01	440.0	--	--	NEGL	--
HFBHC	10	1.3E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.3E-18	3.1E+01	1.3E-18	3.1E+01	0.0E+00	--	288.0	--	--	NEGL	--
HFCGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	NEGL	--
HFCHC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	96.0	--	--	NEGL	--
HFKGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	1500.0	--	--	NEGL	--
HFKHC	10	1.4E-18	3.1E+01	1.4E-18	3.1E+01	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	1.4E-18	3.1E+01	1.4E-18	3.1E+01	1700.0	--	--	NEGL	--
HFKVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	0.0E+00	--	1.4E-18	3.1E+01	0.0E+00	--	1600.0	--	--	NEGL	--
HFMVC	10	1.9E-18	3.1E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.9E-18	3.1E+01	0.0E+00	--	1.9E-18	3.1E+01	1.9E-18	3.1E+01	378.0	--	--	NEGL	--
HFPGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	52.0	--	--	NEGL	--
HFPHC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	93.6	--	--	NEGL	--
HFPVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	48.0	--	--	NEGL	--
HFQGC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	NEGL	--
HFQVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	87.0	--	--	NEGL	--
HFRGC	10	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	1.1E-18	3.1E+01	160.5	--	--	NEGL	--
HFRVC	10	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	0.0E+00	--	1.1E-18	3.1E+01	1.1E-18	3.1E+01	150.0	--	--	NEGL	--
HFSVC	10	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.7E-17	3.1E+01	2.7E-17	3.1E+01	1356.0	--	--	NEGL	--
HFBHC	11	5.8E-11	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.8E-11	2.6E+01	5.8E-11	2.6E+01	0.0E+00	--	288.0	30.0	6.0	--	1hr
HFCGC	11	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.9E-11	2.6E+01	0.0E+00	--	48.0	8.0	1.6	--	1hr
HFCHC	11	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.9E-11	2.6E+01	0.0E+00	--	0.0E+00	--	96.0	16.0	3.2	--	1hr
HFMVC	11	4.3E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	4.3E-11	2.6E+01	0.0E+00	--	4.3E-11	2.6E+01	4.3E-11	2.6E+01	378.0	157.5	31.5	--	1hr
HFPGC	11	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01	52.0	32.5	6.5	--	1hr
HFPHC	11	9.6E-12	2.6E+01	0.0E+00	--	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01	0.0E+00	--	93.6	58.5	11.7	--	1hr
HFPVC	11	9.6E-12	2.6E+01	0.0E+00	--	9.6E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.6E-12	2.6E+01	9.6E-12	2.6E+01	48.0	30.0	6.0	--	1hr
HFQGC	11	7.2E-12	2.6E+01	0.0E+00	--	7.2E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-12	2.6E+01	7.2E-12	2.6E+01	87.0	72.5	14.5	--	1hr
HFQVC	11	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-12	2.6E+01	7.2E-12	2.6E+01	87.0	72.5	14.5	--	1hr
HFRGC	11	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	1.8E-11	2.6E+01	160.5	139.1	21.4	--	1hr
HFRVC	11	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	0.0E+00	--	1.8E-11	2.6E+01	1.8E-11	2.6E+01	150.0	130.0	20.0	--	1hr
HFBHC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	0.0E+00	--	6.0	--	6.0	--	INSTANT
HFCGC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	1.6	--	1.6	--	INSTANT
HFCHC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	3.2	--	3.2	--	INSTANT

ONSITE DISPOSAL OPTION (PER PALLET OR CONTAINER)

Accident Frequencies for Facility Handling Operations (HF) (Events per Pallet or Container) / Agent Available and Released

	SCENARIO NUMBER	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
HFMVC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	10.5	--	10.5	--	INSTANT
HFPGC	12	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	6.5	--	6.5	--	INSTANT
HFPHC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	0.0E+00	--	11.7	--	11.7	--	INSTANT
HFPVC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	6.0	--	6.0	--	INSTANT
HFQGC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	14.5	--	14.5	--	INSTANT
HFQVC	12	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	14.5	--	14.5	--	INSTANT
HFRGC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	10.7	--	10.7	--	INSTANT
HFRVC	12	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	0.0E+00	--	3.0E-10	2.6E+01	3.0E-10	2.6E+01	10.0	--	10.0	--	INSTANT
HFDHC	13	7.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	7.2E-11	2.6E+01	7.2E-11	2.6E+01	0.0E+00	--	288.0	--	6.0	1.70E-03	1hr
HFCGC	13	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-11	2.6E+01	0.0E+00	--	48.0	--	1.6	3.70E-01	1hr
HFCHC	13	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	3.6E-11	2.6E+01	0.0E+00	--	0.0E+00	--	96.0	--	3.2	1.60E-03	1hr
HFMVC	13	5.4E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	5.4E-11	2.6E+01	0.0E+00	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	378.0	--	31.5	3.30E-05	1hr
HFPGC	13	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01	52.0	--	6.5	3.90E-01	1hr
HFPHC	13	1.2E-11	2.6E+01	0.0E+00	--	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01	0.0E+00	--	93.6	--	11.7	1.90E-03	1hr
HFPVC	13	1.2E-11	2.6E+01	0.0E+00	--	1.2E-11	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.2E-11	2.6E+01	1.2E-11	2.6E+01	48.0	--	6.0	1.10E-05	1hr
HFQGC	13	9.0E-12	2.6E+01	0.0E+00	--	9.0E-12	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-12	2.6E+01	9.0E-12	2.6E+01	87.0	--	14.5	4.50E-01	1hr
HFQVC	13	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.0E-12	2.6E+01	9.0E-12	2.6E+01	87.0	--	14.5	1.40E-05	1hr
HFRGC	13	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	2.2E-11	2.6E+01	160.5	--	21.4	9.80E-01	1hr
HFRVC	13	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	0.0E+00	--	2.2E-11	2.6E+01	2.2E-11	2.6E+01	150.0	--	20.0	2.90E-05	1hr
HFDHC	14	1.3E-14	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.3E-14	2.6E+01	1.3E-14	2.6E+01	0.0E+00	--	288.0	30.0	6.0	--	1hr
HFCGC	14	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.6E-15	2.6E+01	0.0E+00	--	48.0	8.0	1.6	--	1hr
HFCHC	14	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	6.6E-15	2.6E+01	0.0E+00	--	0.0E+00	--	96.0	16.0	3.2	--	1hr
HFMVC	14	9.9E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	9.9E-15	2.6E+01	0.0E+00	--	9.9E-15	2.6E+01	9.9E-15	2.6E+01	378.0	157.5	31.5	--	1hr
HFPGC	14	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01	52.0	32.5	6.5	--	1hr
HFPHC	14	2.2E-15	2.6E+01	0.0E+00	--	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01	0.0E+00	--	93.6	58.5	11.7	--	1hr
HFPVC	14	2.2E-15	2.6E+01	0.0E+00	--	2.2E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	2.2E-15	2.6E+01	2.2E-15	2.6E+01	48.0	30.0	6.0	--	1hr
HFQGC	14	1.7E-15	2.6E+01	0.0E+00	--	1.7E-15	2.6E+01	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.7E-15	2.6E+01	1.7E-15	2.6E+01	87.0	72.5	14.5	--	1hr
HFQVC	14	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	0.0E+00	--	1.7E-15	2.6E+01	1.7E-15	2.6E+01	87.0	72.5	14.5	--	1hr
HFRGC	14	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	4.1E-15	2.6E+01	160.5	139.1	21.4	--	1hr
HFRVC	14	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	0.0E+00	--	4.1E-15	2.6E+01	4.1E-15	2.6E+01	150.0	130.0	20.0	--	1hr

I.1.4. PLANT OPERATIONS

The following tables list the results for internal and external accidents during plant operations.

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FLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

Agent Available and Released

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
POAGC	41	3.3E-10	4.8E+01	N/A	--	3.3E-10	3.3E-10	N/A	--	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	262.5	--	--	1.01E+02	15 MIN
POAHC	41	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	262.5	--	--	1.01E+02	15 MIN
POAVC	41	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	3.3E-10	4.8E+01	N/A	--	3.3E-10	4.8E+01	3.3E-10	4.8E+01	175.5	--	--	1.80E+00	15 MIN
POBGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	11.0	--	--	2.20E+01	12 MIN
PODHC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--	21.6	--	--	2.16E+01	12 MIN
POCGC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	5.8	--	--	5.60E+00	12 MIN
POCHC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	11.5	--	--	1.15E+01	12 MIN
POKGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	75.0	--	--	3.75E+01	12 MIN
POKHC	42	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	85.0	--	--	4.25E+01	12 MIN
POKVC	42	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	N/A	--	80.0	--	--	4.00E+01	12 MIN
POMVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	--	--	--	--	--
POPGC	42	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	15.6	--	--	1.56E+01	12 MIN
POPHC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	N/A	--	28.1	--	--	2.81E+01	12 MIN
POPVC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	14.4	--	--	1.44E+01	12 MIN
POQGC	42	9.9E-09	3.7E+01	N/A	--	9.9E-09	3.7E+01	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	19.6	--	--	1.96E+01	12 MIN
POQVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	19.6	--	--	1.96E+01	12 MIN
PORGC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	--	--	--	--	--
PORVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	--	--	--	--	--
POSVC	42	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.9E-09	3.7E+01	9.9E-09	3.7E+01	67.8	--	--	3.39E+01	12 MIN
POBGC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-09	4.1E+01	1.6E-09	4.1E+01	220.0	--	--	NEGL	--
POKGC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-10	4.1E+01	N/A	--	1500.0	--	--	NEGL	--
POKHC	43	2.7E-10	4.1E+01	2.7E-10	4.1E+01	N/A	--	N/A	--	2.7E-10	4.1E+01	N/A	--	2.7E-10	4.1E+01	2.7E-10	4.1E+01	1700.0	--	--	NEGL	--
POKVC	43	N/A	--	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	1600.0	--	--	NEGL	--
POSVC	43	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.8E-10	4.1E+01	1.8E-10	4.1E+01	1356.0	--	--	NEGL	--
POBGC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	4.1E+01	1.6E-10	4.1E+01	220.0	--	--	2.20E+02	2 MIN
POKGC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-10	4.1E+01	N/A	--	1500.0	--	--	1.50E+03	2 MIN
POKHC	44	2.7E-10	4.1E+01	2.7E-10	4.1E+01	N/A	--	N/A	--	2.7E-10	4.1E+01	N/A	--	2.7E-10	4.1E+01	2.7E-10	4.1E+01	1700.0	--	--	1.70E+03	2 MIN
POKVC	44	N/A	--	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	N/A	--	1.5E-10	4.1E+01	N/A	--	1600.0	--	--	1.60E+03	2 MIN

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

Agent Available and Released

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
POSVC	44	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.8E-10	4.1E+01	1.8E-10	4.1E+01	1356.0	--	--	1.36E+03	2 MIN
POKGF	45	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	1500.0	--	--	5.03E+01	106 MIN
POKHF	45	4.0E-10	1.4E+01	4.0E-10	1.4E+01	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--	4.0E-10	1.4E+01	4.0E-10	1.4E+01	1700.0	--	--	2.97E+01	114 MIN
POKVF	45	N/A	--	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--	N/A	--	4.0E-10	1.4E+01	N/A	--	1600.0	--	--	1.91E+01	80 MIN
PODHC	46	9.0E-09	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-09	2.6E+01	9.0E-09	2.6E+01	N/A	--	6.0	--	NEGL	NEGL	--
POCGC	46	1.0E-06	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	2.6E+01	N/A	--	1.6	--	1.00E-01	1.00E-01	60 MIN
POCHC	46	1.0E-08	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	2.6E+01	N/A	--	N/A	--	3.2	--	1.00E-01	3.00E-03	60 MIN
POMVC	46	4.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	4.0E-07	2.6E+01	N/A	--	4.0E-07	2.6E+01	4.0E-07	2.6E+01	10.5	--	NEGL	NEGL	--
POPGC	46	6.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01	6.5	--	6.00E-01	3.00E-01	60 MIN
POPHC	46	6.0E-07	2.6E+01	N/A	--	6.0E-07	2.6E+01	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01	N/A	--	11.7	--	1.00E+00	8.00E-03	60 MIN
POPVC	46	6.0E-07	2.6E+01	N/A	--	6.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	6.0E-07	2.6E+01	6.0E-07	2.6E+01	6.0	--	5.00E-01	NEGL	60 MIN
POQGC	46	3.0E-07	2.6E+01	N/A	--	3.0E-07	2.6E+01	N/A	--	N/A	--	N/A	--	3.0E-07	2.6E+01	3.0E-07	2.6E+01	14.5	--	2.60E+00	2.90E+00	60 MIN
POQVC	46	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-07	2.6E+01	3.0E-07	2.6E+01	14.5	--	2.60E+00	NEGL	60 MIN
PORGC	46	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01	10.7	--	1.00E+00	5.00E-01	60 MIN
PORVC	46	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01	10.0	--	9.00E-01	NEGL	60 MIN
PODHC	47	8.1E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	8.1E-11	3.1E+01	8.1E-11	3.1E+01	N/A	--	6.0	--	NEGL	NEGL	--
POCGC	47	9.0E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-11	3.1E+01	N/A	--	1.6	--	1.00E-01	1.50E-01	20 MIN
POCHC	47	9.0E-11	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-11	3.1E+01	N/A	--	N/A	--	3.2	--	1.00E-01	1.50E-01	20 MIN
POMVC	47	3.6E-09	3.1E+01	N/A	--	N/A	--	N/A	--	3.6E-09	3.1E+01	N/A	--	3.6E-09	3.1E+01	3.6E-09	3.1E+01	10.5	--	NEGL	NEGL	--
POPGC	47	5.4E-09	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01	6.5	--	6.00E-01	6.00E-01	20 MIN
POPHC	47	5.4E-09	3.1E+01	N/A	--	5.4E-09	3.1E+01	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01	N/A	--	11.7	--	1.00E+00	5.00E-01	20 MIN
POPVC	47	5.4E-09	3.1E+01	N/A	--	5.4E-09	3.1E+01	N/A	--	N/A	--	N/A	--	5.4E-09	3.1E+01	5.4E-09	3.1E+01	6.0	--	5.00E-01	1.40E-01	20 MIN
POQGC	47	2.7E-09	3.1E+01	N/A	--	2.7E-09	3.1E+01	N/A	--	N/A	--	N/A	--	2.7E-09	3.1E+01	2.7E-09	3.1E+01	14.5	--	2.60E+00	1.20E+00	20 MIN
POQVC	47	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-09	3.1E+01	2.7E-05	3.1E+01	14.5	--	2.60E+00	3.00E-01	20 MIN
PORGC	47	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01	10.7	--	1.00E+00	1.00E+00	20 MIN
PORVC	47	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	N/A	--	1.5E-07	2.7E+01	1.5E-07	2.7E+01	10.0	--	9.00E-01	2.00E-01	20 MIN
PODHC	48	9.0E-12	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.0E-12	3.3E+01	9.0E-12	3.3E+01	N/A	--	1728.0	--	2.16E+02	3.20E+01	20 MIN
POCGC	48	1.0E-11	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-11	3.3E+01	N/A	--	230.4	--	5.80E+01	1.72E+01	20 MIN

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

Agent Available and Released

SCENARIO ID	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
POCHC	48	1.0E-11	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-11	3.3E+01	N/A	--	N/A	--	460.8	--	1.15E+02	1.72E+01	20 MIN
POMVC	48	4.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	4.0E-10	3.3E+01	N/A	--	4.0E-10	3.3E+01	4.0E-10	3.3E+01	2268.0	--	5.67E+02	4.30E+01	20 MIN
POPGC	48	6.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01	312.0	--	7.90E+01	2.36E+01	20 MIN
POPHC	48	6.0E-10	3.3E+01	N/A	--	6.0E-10	3.3E+01	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01	N/A	--	561.6	--	1.42E+02	2.15E+01	20 MIN
POPVC	48	6.0E-10	3.3E+01	N/A	--	6.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	6.0E-10	3.3E+01	6.0E-10	3.3E+01	288.0	--	7.25E+01	5.10E+00	20 MIN
POQGC	48	3.0E-10	3.3E+01	N/A	--	3.0E-10	3.3E+01	N/A	--	N/A	--	N/A	--	3.0E-10	3.3E+01	3.0E-10	3.3E+01	522.0	--	1.34E+02	4.02E+01	20 MIN
POQVC	48	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-10	3.3E+01	3.0E-10	3.3E+01	522.0	--	1.34E+02	1.03E+01	20 MIN
PORGC	48	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	1.5E-09	3.2E+01	963.0	--	2.42E+02	7.30E+01	20 MIN
PORVC	48	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	N/A	--	1.5E-09	3.2E+01	1.5E-09	3.2E+01	900.0	--	2.26E+02	1.72E+01	20 MIN
PODHC	49	3.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-06	3.1E+01	3.0E-06	3.1E+01	N/A	--	6.0	--	6.00E+00	--	INSTANT
PDCGC	49	4.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-06	3.1E+01	N/A	--	1.6	--	1.60E+00	--	INSTANT
PDCHC	49	4.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-06	3.1E+01	N/A	--	N/A	--	3.2	--	3.20E+00	--	INSTANT
POMVC	49	4.0E-09	3.7E+01	N/A	--	N/A	--	N/A	--	4.0E-09	3.7E+01	N/A	--	4.0E-09	3.7E+01	4.0E-09	3.7E+01	10.5	--	1.05E+01	--	INSTANT
POPGC	49	2.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01	6.5	--	6.50E+00	--	INSTANT
POPHC	49	2.0E-06	3.1E+01	N/A	--	2.0E-06	3.1E+01	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01	N/A	--	11.7	--	1.17E+01	--	INSTANT
POPVC	49	2.0E-06	3.1E+01	N/A	--	2.0E-06	3.1E+01	N/A	--	N/A	--	N/A	--	2.0E-06	3.1E+01	2.0E-06	3.1E+01	6.0	--	6.00E+00	--	INSTANT
POQGC	49	8.0E-07	3.1E+01	N/A	--	8.0E-07	3.1E+01	N/A	--	N/A	--	N/A	--	8.0E-07	3.1E+01	8.0E-07	3.1E+01	14.5	--	1.45E+01	--	INSTANT
POQVC	49	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-07	3.1E+01	8.0E-07	3.1E+01	14.5	--	1.45E+01	--	INSTANT
PORGC	49	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01	10.7	--	1.07E+01	--	INSTANT
PORVC	49	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01	10.0	--	1.00E+01	--	INSTANT
PODHC	50	3.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-08	3.7E+01	3.0E-08	3.7E+01	N/A	--	6.0	--	6.00E+00	--	INSTANT
PDCGC	50	4.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-08	3.7E+01	N/A	--	1.6	--	1.60E+00	--	INSTANT
POCHC	50	4.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-08	3.7E+01	N/A	--	N/A	--	3.2	--	3.20E+00	--	INSTANT
POMVC	50	4.0E-11	3.7E+01	N/A	--	N/A	--	N/A	--	4.0E-11	3.7E+01	N/A	--	4.0E-11	3.7E+01	4.0E-11	3.7E+01	10.5	--	1.05E+01	--	INSTANT
POPGC	50	2.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01	6.5	--	6.50E+00	--	INSTANT
POPHC	50	2.0E-08	3.7E+01	N/A	--	2.0E-08	3.7E+01	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01	N/A	--	11.7	--	1.17E+01	--	INSTANT
POPVC	50	2.0E-08	3.7E+01	N/A	--	2.0E-08	3.7E+01	N/A	--	N/A	--	N/A	--	2.0E-08	3.7E+01	2.0E-08	3.7E+01	6.0	--	6.00E+00	--	INSTANT
POQGC	50	8.0E-09	3.7E+01	N/A	--	8.0E-09	3.7E+01	N/A	--	N/A	--	N/A	--	8.0E-09	3.7E+01	8.0E-09	3.7E+01	14.5	--	1.45E+01	--	INSTANT

PLANT OPERATIONS INTERNAL INITIATING EVENTS
ONSITE DISPOSAL OPTION MEDIAN ACCIDENT FREQUENCY (PER FACILITY-YEAR)

Agent Available and Released

SCENARIO ID	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAIL	LBS SPILLED	LBS DETONATED	LBS EMITTED	DURATION TIME
POQVC	50	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-09	3.7E+01	8.0E-09	3.7E+01	14.5	--	1.45E+01	--	INSTANT
PORGC	50	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01	10.7	--	1.07E+01	--	INSTANT
PORVC	50	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	N/A	--	5.0E-07	3.4E+01	5.0E-07	3.4E+01	10.0	--	1.00E+01	--	INSTANT
POKGF	51	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	1500.0	--	--	2.90E+01	61.4 MIN
POKHF	51	4.0E-09	1.4E+01	4.0E-09	1.4E+01	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	4.0E-09	1.4E+01	4.0E-09	1.4E+01	1700.0	--	--	1.80E+01	69.3 MIN
POKVF	51	N/A	--	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	N/A	--	4.0E-09	1.4E+01	N/A	--	1600.0	--	--	5.80E+00	34.7 MIN
PODHC	52	4.4E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-03	5.7E+01	4.4E-03	5.7E+01	N/A	--	6.0	--	6.00E+00	--	INSTANT
POCGC	52	5.0E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-03	5.7E+01	N/A	--	1.6	--	1.60E+00	--	INSTANT
POCHC	52	5.0E-03	5.7E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.0E-03	5.7E+01	N/A	--	N/A	--	3.2	--	3.20E+00	--	INSTANT
POMVC	52	1.1E-02	5.7E+01	N/A	--	N/A	--	N/A	--	1.1E-02	5.7E+01	N/A	--	1.1E-02	5.7E+01	1.1E-02	5.7E+01	10.5	--	1.05E+01	--	INSTANT
POPGC	52	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	6.5	--	6.50E+00	--	INSTANT
POPHC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--	11.7	--	1.17E+01	--	INSTANT
POPVC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	6.0	--	6.00E+00	--	INSTANT
POQGC	52	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	14.5	--	1.45E+01	--	INSTANT
POQVC	52	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	14.5	--	1.45E+01	--	INSTANT
PORGC	52	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	1.6E-03	5.7E+01	10.7	--	1.07E+01	--	INSTANT
PORVC	52	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	N/A	--	1.6E-03	5.7E+01	1.6E-03	5.7E+01	10.0	--	1.00E+01	--	INSTANT

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
P01 - Tornado-generated missile puncture/crush munitions in the MHI.																						
POBGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-16	9.4E+01	1.2E-15	9.4E+01	7040.0	--	--	5.30E-01	2 HR
PODHC	1	8.0E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	7.3E-14	9.4E+01	1.3E-15	9.4E+01	N/A	--	4608.0	--	--	2.40E-02	2 HR
POCGC	1	2.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.3E-16	9.4E+01	N/A	--	614.4	--	--	5.30E-01	2 HR
POCHC	1	2.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-14	9.4E+01	N/A	--	N/A	--	1228.8	--	--	2.40E-02	2 HR
POKGC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-16	9.4E+01	N/A	--	24000.0	--	--	1.60E+00	2 HR
POKHC	1	1.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	3.1E-13	9.4E+01	N/A	--	2.0E-16	9.4E+01	7.7E-16	9.4E+01	27200.0	--	--	3.00E-01	2 HR
POKVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-16	9.4E+01	N/A	--	25600.0	--	--	3.00E-04	2 HR
POMVC	1	9.5E-13	9.4E+01	N/A	--	N/A	--	N/A	--	1.3E-12	9.4E+01	N/A	--	1.5E-15	9.4E+01	5.8E-15	9.4E+01	6048.0	--	--	2.00E-04	2 HR
POPGC	1	2.8E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.7E-16	9.4E+01	4.8E-15	9.4E+01	832.0	--	--	5.30E-01	2 HR
POPHC	1	2.8E-13	9.4E+01	N/A	--	4.9E-13	9.4E+01	N/A	--	N/A	--	3.8E-14	9.4E+01	5.7E-16	9.4E+01	N/A	--	1497.6	--	--	2.40E-02	2 HR
POPVC	1	2.8E-13	9.4E+01	N/A	--	4.9E-13	9.4E+01	N/A	--	N/A	--	N/A	--	5.7E-16	9.4E+01	4.8E-15	9.4E+01	768.0	--	--	2.00E-04	2 HR
POQGC	1	2.8E-13	9.4E+01	N/A	--	5.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	6.8E-16	9.4E+01	5.8E-15	9.4E+01	1392.0	--	--	5.30E-01	2 HR
POQVC	1	2.8E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.8E-16	9.4E+01	5.8E-15	9.4E+01	1392.0	--	--	2.00E-04	2 HR
PORGC	1	8.6E-13	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.4E-15	9.4E+01	5.8E-15	9.4E+01	2568.0	--	--	5.30E-01	2 HR
PORVC	1	8.6E-13	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.2E-12	9.4E+01	N/A	--	1.4E-15	9.4E+01	5.8E-15	9.4E+01	2400.0	--	--	2.00E-04	2 HR
POSVC	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.7E-16	9.4E+01	3.5E-15	9.4E+01	21696.0	--	--	3.00E-04	2 HR
Tornado-generated missile detonate munitions in the MHI.																						
PODHC	2	1.7E-13	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-14	--	2.8E-16	9.9E+01	N/A	--	4608.0	--	6.00E+00	8.00E-03	2 HR
POCGC	2	4.5E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.1E-17	9.9E+01	N/A	--	614.4	--	1.60E+00	1.60E-01	2 HR
POCHC	2	4.5E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.1E-15	9.9E+01	N/A	--	N/A	--	1228.8	--	3.20E+00	4.00E-03	2 HR
POMVC	2	2.0E-13	9.9E+01	N/A	--	N/A	--	N/A	--	2.7E-13	9.9E+01	N/A	--	3.3E-16	9.9E+01	3.3E-16	9.9E+01	6048.0	--	3.15E+01	2.59E-01	2 HR
POPGC	2	5.9E-14	9.9E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-17	9.9E+01	1.2E-16	9.9E+01	832.0	--	6.50E+00	5.00E-03	2 HR
POPHC	2	5.9E-14	9.9E+01	N/A	--	1.0E-13	9.9E+01	N/A	--	N/A	--	8.0E-15	9.9E+01	1.2E-16	9.9E+01	N/A	--	1497.6	--	1.17E+01	4.00E-05	2 HR
POPVC	2	5.9E-14	9.9E+01	N/A	--	1.0E-13	9.9E+01	N/A	--	N/A	--	N/A	--	1.2E-16	9.9E+01	1.2E-17	9.9E+01	768.0	--	6.00E+00	4.38E-01	2 HR
POQGC	2	5.9E-14	9.9E+01	N/A	--	1.2E-13	9.9E+01	N/A	--	N/A	--	N/A	--	1.4E-16	9.9E+01	1.4E-16	9.9E+01	1392.0	--	1.45E+01	5.00E-05	2 HR
POQVC	2	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-16	9.9E+01	1.4E-16	9.9E+01	1392.0	--	1.45E+01	7.67E-01	2 HR
PORGC	2	1.8E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	3.0E-16	9.9E+01	3.0E-16	9.9E+01	2568.0	--	2.14E+01	6.00E-05	2 HR
PORVC	2	1.8E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	2.5E-13	9.9E+01	N/A	--	3.0E-16	9.9E+01	3.0E-16	9.9E+01	2400.0	--	2.00E+01	N/A	2 HR
Tornado-generated missile puncture/crush munitions in the UPA.																						

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
PDBEC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.1E-15	9.4E+01	2.1E-15	9.4E+01	2640.0	--	--	5.30E-01	1 HR
PODHC	3	6.6E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-13	9.4E+01	7.9E-15	9.4E+01	N/A	--	1728.0	--	--	2.40E-02	1 HR
POCGC	3	2.3E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-15	9.4E+01	N/A	--	230.4	--	--	5.30E-01	1 HR
POCHC	3	2.3E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-13	9.4E+01	N/A	--	N/A	--	460.8	--	--	2.40E-02	1 HR
POKGC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.6E-15	9.4E+01	N/A	--	9000.0	--	--	1.44E+00	1 HR
POKHC	3	3.6E-12	9.4E+01	1.2E-13	9.4E+01	N/A	--	N/A	--	3.6E-12	9.4E+01	N/A	--	3.6E-15	9.4E+01	1.1E-15	9.4E+01	10200.0	--	--	7.00E-02	1 HR
POKVC	3	N/A	--	N/A	--	N/A	--	3.6E-12	9.4E+01	N/A	--	N/A	--	3.6E-15	9.4E+01	N/A	--	9600.0	--	--	NEGL	1 HR
PONVC	3	6.0E-13	9.4E+01	N/A	--	N/A	--	N/A	--	7.7E-12	9.4E+01	N/A	--	9.2E-15	9.4E+01	7.9E-15	9.4E+01	2268.0	--	--	2.00E-04	1 HR
POPGC	3	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	8.8E-15	9.4E+01	312.0	--	--	5.30E-01	1 HR
POFHC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	4.9E-13	9.4E+01	4.1E-15	9.4E+01	N/A	--	561.6	--	--	2.40E-02	1 HR
POPVC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	8.8E-15	9.4E+01	288.0	--	--	2.00E-04	1 HR
PODGC	3	3.5E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	9.2E-15	9.4E+01	522.0	--	--	5.30E-01	1 HR
PODVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.1E-15	9.4E+01	9.2E-15	9.4E+01	522.0	--	--	2.00E-04	1 HR
PORGC	3	7.1E-12	9.4E+01	N/A	--	7.1E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	8.5E-15	9.4E+01	4.1E-15	9.4E+01	963.0	--	--	5.30E-01	1 HR
PORVC	3	7.1E-12	9.4E+01	N/A	--	7.1E-12	9.4E+01	N/A	--	3.5E-12	9.4E+01	N/A	--	8.5E-15	9.4E+01	4.1E-15	9.4E+01	900.0	--	--	2.00E-04	1 HR
POSVC	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.5E-14	9.4E+01	4.1E-15	9.4E+01	8136.0	--	--	NEGL	1 HR
Tornado-generated missile detonate munitions in the UPA.																						
PODHC	4	7.1E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-14	9.4E+01	8.5E-16	9.4E+01	N/A	--	1728.0	--	6.00E+00	NEGL	2 HR
POCGC	4	2.4E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-16	9.4E+01	N/A	--	230.4	--	1.60E+00	1.32E-01	2 HR
POCHC	4	2.4E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-14	9.4E+01	N/A	--	N/A	--	460.8	--	3.20E+00	NEGL	2 HR
PONVC	4	8.2E-13	9.4E+01	N/A	--	N/A	--	N/A	--	8.2E-13	9.4E+01	N/A	--	9.8E-16	9.4E+01	9.8E-16	9.4E+01	2268.0	--	3.15E+01	NEGL	2 HR
POPGC	4	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01	312.0	--	6.50E+00	2.31E-01	2 HR
POFHC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	2.5E-14	9.4E+01	4.4E-16	9.4E+01	N/A	--	561.6	--	1.17E+01	NEGL	2 HR
POPVC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01	288.0	--	6.00E+00	NEGL	2 HR
PODGC	4	3.7E-13	9.4E+01	N/A	--	3.7E-13	9.4E+01	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01	522.0	--	1.45E+01	4.10E-01	2 HR
PODVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.4E-16	9.4E+01	4.4E-16	9.4E+01	522.0	--	1.45E+01	NEGL	2 HR
PORGC	4	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	4.4E-16	9.4E+01	9.1E-16	9.4E+01	963.0	--	2.14E+01	7.19E-01	2 HR
PORVC	4	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	7.6E-13	9.4E+01	N/A	--	4.4E-16	9.4E+01	9.1E-16	9.4E+01	900.0	--	2.00E+01	NEGL	2 HR
PO5 - Tornado-generated missile damages the agent piping system between the DDS and TOX at TEAD (bulk-only facility).																						
POAGS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--	--	5.40E+02	--	--	1 HR

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
POAHS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--	--	6.38E+02	--	--	1 HR
POAVS	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-11	9.4E+01	N/A	--	--	5.07E+02	--	--	1 HR

Notes:

1. Frequency unit = events/operating year
2. Scenario 5 applies only to the TEAD bulk-only facility

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

																		AGENT RELEASE				
SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
PO6 - Meteorite strikes the MHI.																						
PODGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-15	2.6E+01	1.4E-15	2.6E+01	7040.0	--	--	7.04E+02	1 HR
PODHC	6	9.8E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-16	2.6E+01	9.8E-16	2.6E+01	N/A	--	4608.0	--	1.15E+03	1.73E+02	20 MIN
POCGC	6	6.0E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-16	2.6E+01	N/A	--	614.4	--	1.54E+02	4.61E+01	20 MIN
POCHC	6	6.0E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-16	2.6E+01	N/A	--	N/A	--	1228.8	--	3.07E+02	4.61E+01	20 MIN
POKGF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	24000.0	--	--	2.40E+03	1 HR
POKHF	6	2.0E-15	2.6E+01	2.0E-15	2.6E+01	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	2.0E-15	2.6E+01	2.0E-15	2.6E+01	27200.0	--	--	1.36E+03	1 HR
POKVF	6	N/A	--	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	N/A	--	2.0E-15	2.6E+01	N/A	--	25600.0	--	--	6.40E+02	1 HR
POMVC	6	1.5E-15	2.6E+01	N/A	--	N/A	--	N/A	--	1.5E-15	2.6E+01	N/A	--	1.5E-15	2.6E+01	1.5E-15	2.6E+01	6048.0	--	1.51E+03	1.13E+02	20 MIN
POPGC	6	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	832.0	--	2.08E+02	6.24E+01	20 MIN
POPHC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	N/A	--	1497.6	--	3.74E+02	5.62E+01	20 MIN
POPVC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	768.0	--	1.92E+02	1.44E+01	20 MIN
POQGC	6	4.6E-16	2.6E+01	N/A	--	4.6E-16	2.6E+01	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	1392.0	--	3.48E+02	1.04E+02	20 MIN
POQVC	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.6E-16	2.6E+01	4.6E-16	2.6E+01	1392.0	--	3.48E+02	2.61E+01	20 MIN
PORGC	6	2.1E-15	2.6E+01	N/A	-	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	2.1E-15	2.6E+01	2568.0	--	6.42E+02	1.93E+02	20 MIN
PORVC	6	3.4E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	N/A	--	2.1E-15	2.6E+01	2.1E-15	2.6E+01	2400.0	--	6.00E+02	4.50E+01	20 MIN
POSVF	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.4E-15	2.6E+01	3.4E-15	2.6E+01	21696.0	--	--	5.42E+02	1 HR
PO7 - Meteorite strikes the UPA.																						
POBGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	2.6E+01	2.9E-12	2.6E+01	2640.0	--	--	2.64E+02	1 HR
PODHC	7	2.0E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.0E-12	2.6E+01	2.0E-12	2.6E+01	N/A	--	1728.0	--	4.32E+02	6.48E+01	20 MIN
POCGC	7	1.1E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-12	2.6E+01	N/A	--	230.4	--	5.76E+01	1.73E+01	20 MIN
POCHC	7	1.1E-12	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-12	2.6E+01	N/A	--	N/A	--	460.8	--	1.15E+02	1.73E+01	20 MIN
POKGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	9000.0	--	--	9.00E+02	1 HR
POKHF	7	4.0E-12	2.6E+01	4.0E-12	2.6E+01	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01	10200.0	--	--	5.10E+02	1 HR
POKVF	7	N/A	--	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	N/A	--	4.0E-12	2.6E+01	N/A	--	9600.0	--	--	2.40E+02	1 HR
POMVC	7	2.9E-12	2.6E+01	N/A	--	N/A	--	N/A	--	2.9E-12	2.6E+01	N/A	--	2.9E-12	2.6E+01	2.9E-12	2.6E+01	2268.0	--	5.67E+02	4.25E+01	20 MIN
POPGC	7	8.8E-13	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	312.0	--	7.80E+01	2.34E+01	20 MIN
POPHC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	N/A	--	561.6	--	1.40E+02	2.11E+01	20 MIN
POPVC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	288.0	--	7.20E+01	5.40E+00	20 MIN
POQGC	7	8.8E-13	2.6E+01	N/A	--	8.8E-13	1.7E+01	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	522.0	--	1.31E+02	3.92E+01	20 MIN

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

																		AGENT RELEASE				
SCENARIO I.D.	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
POGVC	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.8E-13	2.6E+01	8.8E-13	2.6E+01	522.0	--	1.31E+02	9.79E+00	20 MIN
PORGC	7	4.0E-12	2.6E+01	N/A	--	4.0E-12	1.7E+01	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01	963.0	--	2.41E+02	7.22E+01	20 MIN
PORVC	7	4.0E-12	2.6E+01	N/A	--	4.0E-12	1.7E+01	N/A	--	4.0E-12	2.6E+01	N/A	--	4.0E-12	2.6E+01	4.0E-12	2.6E+01	900.0	--	2.25E+02	1.69E+01	20 MIN
POSVF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.7E-12	2.6E+01	6.7E-12	2.6E+01	8136.0	--	--	2.03E+02	1 HR
P07A - Meteorite strikes the TOX.																						
POASF	7A	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	16.4	--	--	1.64E+00	1 HR
POAHF	7A	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	19.1	--	--	9.53E-01	1 HR
POAVF	7A	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	3.4E-13	2.6E+01	N/A	--	3.4E-13	2.6E+01	3.4E-13	2.6E+01	15.1	--	--	3.78E-01	1 HR
P08 - Meteorite strikes the agent piping system between the BDS and TOX at TEAD (bulk-only facility).																						
POASF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--	--	--	--	5.48E+01	10 MIN
POAHF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--	--	--	--	3.19E+01	10 MIN
POAVF	8	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-11	1.7E+01	N/A	--	--	--	--	1.27E+01	10 MIN

Notes:

1. Frequency unit = events/operating year
2. Scenario 8 applies only to the TEAD bulk-only facility

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
P09 - Direct large aircraft crash onto the MHI; no fire																						
PDBGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	7040.0	2.11E+03	--	--	6 HR
PODHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	--	4608.0	1.15E+03	2.30E+02	--	6 HR
POCGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--	614.4	1.54E+02	3.07E+01	--	6 HR
POCHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	N/A	--	N/A	--	1228.8	3.07E+02	6.14E+01	--	6 HR
POKGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--	24000.0	7.20E+03	--	--	6 HR
POKHS	9	2.6E-10	1.0E+01	1.8E-11	1.0E+01	N/A	--	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	27200.0	8.16E+03	--	--	6 HR
POKVS	9	N/A	--	N/A	--	N/A	--	1.50E-10	1.0E+01	N/A	--	N/A	--	1.2E-11	1.0E+01	N/A	--	25600.0	7.68E+03	--	--	6 HR
POMVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	6048.0	2.42E+03	3.02E+02	--	6 HR
POPGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	832.0	2.08E+02	4.16E+01	--	6 HR
POPHC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	2.0E-09	1.0E+01	1.2E-11	1.0E+01	N/A	--	1497.6	3.74E+02	7.49E+01	--	6 HR
POPVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	768.0	1.92E+02	3.84E+01	--	6 HR
POQGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	1392.0	3.48E+02	6.96E+01	--	6 HR
POQVC	9	N/A	--	N/A	--	1.5E-10	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	1392.0	3.48E+02	6.96E+01	--	6 HR
PORGC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	2568.0	1.03E+03	1.28E+02	--	6 HR
PORVC	9	2.6E-10	1.0E+01	N/A	--	1.5E-10	1.0E+01	N/A	--	5.0E-11	1.0E+01	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	2400.0	9.60E+02	1.20E+02	--	6 HR
POSVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.2E-11	1.0E+01	5.0E-10	1.0E+01	21696.0	6.51E+03	--	--	6 HR
PO10 - Direct large aircraft crash onto the MHI; fire not contained in 0.5 hours																						
POBGF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	7040.0	--	--	7.04E+02	1 HR
PODHC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	4.1E-11	1.0E+01	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	--	4608.0	--	1.15E+03	1.73E+02	20 MIN
POCGC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--	614.4	--	1.54E+02	4.61E+01	20 MIN
POCHC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-09	1.0E+01	N/A	--	N/A	--	1228.8	--	3.07E+02	4.61E+01	20 MIN
POKGF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--	24000.0	--	--	2.40E+03	1 HR
POKHF	10	2.2E-10	1.0E+01	1.4E-11	1.0E+01	N/A	--	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	27200.0	--	--	1.36E+03	1 HR
POKVF	10	N/A	--	N/A	--	N/A	--	1.3E-10	1.0E+01	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--	25600.0	--	--	6.40E+02	1 HR
POMVC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	6048.0	--	1.51E+03	1.13E+02	20 MIN
POPGC	10	2.2E-10	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	832.0	--	2.08E+02	6.24E+01	20 MIN
POPHC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	1.6E-09	1.0E+01	9.8E-12	1.0E+01	N/A	--	1497.6	--	3.74E+02	5.62E+01	20 MIN
POPVC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	768.0	--	1.92E+02	1.44E+01	20 MIN
POQGC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	N/A	--	1392.0	--	3.48E+02	1.04E+02	20 MIN

See notes at end of table.

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
FODVC	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	1392.0	--	3.48E+02	2.61E+01	20 MIN
PORGC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	2568.0	--	6.42E+02	1.93E+02	20 MIN
PORVC	10	2.2E-10	1.0E+01	N/A	--	1.2E-10	1.0E+01	N/A	--	4.1E-11	1.0E+01	N/A	--	9.8E-12	1.0E+01	4.1E-10	1.0E+01	2400.0	--	6.00E+02	4.50E+01	20 MIN
POSVF	10	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.8E-12	1.0E+01	N/A	--	21696.0	--	--	5.42E+02	1 HR
PO11 - Direct large aircraft crash onto the MH1; fire contained in 0.5 hours																						
POBGF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--	7040.0	--	--	2.11E+02	1 HR
POKGF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--	24000.0	--	--	7.20E+02	1 HR
POKHF	11	7.3E-14	1.3E+01	4.90E-15	1.3E+01	N/A	--	N/A	--	1.4E-14	1.3E+01	N/A	--	3.3E-15	1.3E+01	1.4E-13	1.3E+01	27200.0	--	--	4.08E+02	1 HR
POKVF	11	N/A	--	N/A	--	N/A	--	4.30E-14	1.3E+01	N/A	--	N/A	--	3.3E-15	1.3E+01	N/A	--	25600.0	--	--	1.92E+02	1 HR
POSVF	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-15	1.3E+01	1.4E-13	1.3E+01	21696.0	--	--	1.63E+02	1 HR
PO12 - Direct large aircraft crash damages the MDB; no fire																						
POBGS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	2656.4	2.22E+03	--	--	6 HR
PODHC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.5E-09	1.0E+01	5.7E-08	1.0E+01	3.5E-10	1.0E+01	N/A	--	1747.1	1.22E+03	2.59E+02	--	6 HR
POCGC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--	246.8	1.73E+02	3.46E+01	--	6 HR
POCHC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.7E-08	1.0E+01	N/A	--	N/A	--	479.9	3.36E+02	6.91E+01	--	6 HR
POKGS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--	9016.4	7.52E+03	--	--	6 HR
POKHS	12	7.7E-09	1.0E+01	5.1E-10	1.0E+01	N/A	--	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	10219.1	8.52E+03	--	--	6 HR
POKVS	12	N/A	--	N/A	--	N/A	--	4.5E-09	1.0E+01	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--	9615.1	8.02E+03	--	--	6 HR
PONVC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	2283.1	1.60E+03	3.40E+02	--	6 HR
POPGC	12	7.7E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	328.4	2.30E+02	4.68E+01	--	6 HR
POPHC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	5.7E-08	1.0E+01	3.5E-10	1.0E+01	N/A	--	580.7	4.06E+02	8.42E+01	--	6 HR
POPVC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	303.1	2.12E+02	4.32E+01	--	6 HR
PODGC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	N/A	--	538.4	3.77E+02	7.83E+01	--	6 HR
PODVC	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	537.1	3.76E+02	7.83E+01	--	6 HR
PORGC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	979.3	6.86E+02	1.44E+02	--	6 HR
PORVC	12	7.7E-09	1.0E+01	N/A	--	4.4E-09	1.0E+01	N/A	--	1.5E-09	1.0E+01	N/A	--	3.5E-10	1.0E+01	1.5E-08	1.0E+01	915.1	6.41E+02	1.35E+02	--	6 HR
POSVS	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.5E-10	1.0E+01	N/A	--	8151.1	6.80E+03	--	--	6 HR
PO13 - Direct large aircraft crash damages the MDB; fire not contained in 0.5 hours																						
POBGF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	2656.4	--	--	2.66E+02	1 HR
PODHC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-09	1.0E+01	4.7E-08	1.0E+01	2.9E-10	1.0E+01	N/A	--	1747.1	--	4.32E+02	6.55E+01	20 MIN

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
POCGC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--	246.8	--	5.76E+01	1.85E+01	20 MIN
POCMC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-08	1.0E+01	N/A	--	N/A	--	479.9	--	1.15E+02	1.00E+01	20 MIN
POKGF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--	9016.4	--	--	9.02E+02	1 HR
POKMF	13	6.3E-09	1.0E+01	4.2E-10	--	N/A	--	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	10219.1	--	--	5.11E+02	1 HR
POKVF	13	N/A	--	N/A	--	N/A	--	3.6E-09	1.0E+01	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--	9615.1	--	--	2.40E+02	1 HR
POMVC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	2283.1	--	5.67E+02	4.20E+01	20 MIN
POPGC	13	6.3E-09	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	328.4	--	7.80E+01	2.46E+01	20 MIN
POPMC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	4.7E-08	1.0E+01	2.9E-10	1.0E+01	N/A	--	580.7	--	1.40E+02	2.10E+01	20 MIN
POPVC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	303.1	--	7.20E+01	5.60E+00	20 MIN
POQGC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	N/A	--	538.4	--	1.31E+02	4.04E+01	20 MIN
POQVC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	537.1	--	1.31E+02	1.01E+01	20 MIN
PORGC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	979.3	--	2.41E+02	7.35E+01	20 MIN
PORVC	13	6.3E-09	1.0E+01	N/A	--	3.6E-09	1.0E+01	N/A	--	1.2E-09	1.0E+01	N/A	--	2.9E-10	1.0E+01	1.2E-08	1.0E+01	915.1	--	2.25E+02	1.72E+01	20 MIN
POSVF	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-10	1.0E+01	N/A	--	8151.1	--	--	2.04E+02	1 HR
PD14 - Direct large aircraft crash damages the MDB; fire contained in 0.5 hours																						
POBGF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01	2656.4	--	--	2.30E+02	30 MIN
POKGF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	N/A	--	9016.4	--	--	7.60E+02	30 MIN
POKMF	14	2.1E-12	1.3E+01	1.4E-13	1.3E+01	N/A	--	N/A	--	4.1E-13	1.3E+01	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01	10219.1	--	--	4.30E+02	30 MIN
POKVF	14	N/A	--	N/A	--	N/A	--	1.2E-12	1.3E+01	N/A	--	N/A	--	9.7E-14	1.3E+01	N/A	--	9615.1	--	--	2.03E+02	30 MIN
POSVF	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9.7E-14	1.3E+01	4.1E-12	1.3E+01	8151.1	--	--	1.72E+02	30 MIN
PD15 - Indirect large aircraft crash damages the MHI; no fire																						
POBGS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	7040.0	--	0.00E+00	6.30E+00	1 hr
POBMC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-10	1.3E+01	2.9E-12	1.3E+01	N/A	--	4600.0	--	0.00E+00	NS	1 hr
POCGC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--	614.4	--	0.00E+00	1.25E-01	1 hr
POCMC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-10	1.3E+01	N/A	--	N/A	--	1720.0	--	0.00E+00	NS	1 hr
POKGS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--	24000.0	--	0.00E+00	6.30E+00	1 hr
POKMS	15	6.3E-11	1.3E+01	4.20E-12	1.3E+01	N/A	--	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	27200.0	--	0.00E+00	NS	1 hr
POKVS	15	N/A	--	N/A	--	N/A	--	3.70E-11	1.3E+01	N/A	--	N/A	--	2.9E-12	1.3E+01	N/A	--	25600.0	--	0.00E+00	NS	1 hr
POMVC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	6040.0	-	3.15E+01	NS	1 hr
POPGC	15	6.3E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	832.0	--	0.00E+00	2.00E-01	1 hr

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

AGENT RELEASE

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
POPHC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	4.7E-10	1.3E+01	2.9E-12	1.3E+01	N/A	--	1497.6	--	0.00E+00	NS	1 hr
POPVC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	768.0	--	0.00E+00	NS	1 hr
POOGC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	1392.0	--	0.00E+00	4.53E-01	1 hr
POOVC	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	1392.0	--	0.00E+00	NS	1 hr
PORGC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	2568.0	--	2.14E+01	5.65E-01	1 hr
PORVC	15	6.3E-11	1.3E+01	N/A	--	3.6E-11	1.3E+01	N/A	--	1.2E-11	1.3E+01	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	2400.0	--	2.00E+01	NS	1 hr
POSVS	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.9E-12	1.3E+01	1.2E-10	1.3E+01	21696.0	--	0.00E+00	NS	1 hr
PO16 - Indirect large aircraft crash damages the MHI; fire not contained in 0.5 hours																						
POBGF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01	7040.0	--	--	7.04E+02	1 HR
PODHC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-10	1.3E+01	2.4E-12	1.3E+01	N/A	--	4608.0	--	1.15E+03	1.73E+02	20 MIN
POCGC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	N/A	--	614.4	--	1.54E+02	4.61E+01	20 MIN
POCHC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-10	1.3E+01	N/A	--	N/A	--	1228.8	--	3.07E+02	4.61E+01	20 MIN
POKGF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	N/A	--	24000.0	--	--	2.40E+03	1 HR
POKMF	16	5.1E-11	1.3E+01	3.50E-12	1.3E+01	N/A	--	N/A	--	9.8E-12	1.3E+01	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01	27200.0	--	--	1.36E+03	1 HR
POKVF	16	N/A	--	N/A	--	N/A	--	3.00E-11	1.3E+01	N/A	--	N/A	--	2.3E-12	1.3E+01	N/A	--	25600.0	--	--	6.40E+02	1 HR
POMVC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	6048.0	--	1.51E+03	1.13E+02	20 MIN
POPGC	16	5.2E-11	1.3E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	832.0	--	2.08E+02	6.24E+01	20 MIN
POPHC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	3.9E-10	1.3E+01	2.4E-12	1.3E+01	N/A	--	1497.6	--	3.74E+02	5.62E+01	20 MIN
POPVC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	768.0	--	1.92E+02	1.44E+01	20 MIN
POOGC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	1392.0	--	3.48E+02	1.04E+02	20 MIN
POOVC	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	1392.0	--	3.48E+02	2.61E+01	20 MIN
PORGC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	2568.0	--	6.42E+02	1.93E+02	20 MIN
PORVC	16	5.2E-11	1.3E+01	N/A	--	2.9E-11	1.3E+01	N/A	--	9.8E-12	1.3E+01	N/A	--	2.4E-12	1.3E+01	9.8E-11	1.3E+01	2400.0	--	6.00E+02	4.50E+01	20 MIN
POSVF	16	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.3E-12	1.3E+01	9.8E-11	1.3E+01	21696.0	--	--	5.42E+02	1 HR
PO17 - Indirect large aircraft crash damages the MHI; fire contained in 0.5 hours																						
POBGF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01	7040.0	--	--	2.20E+01	30 min
POKGF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	N/A	--	24000.0	--	--	1.50E+02	30 min
POKMF	17	1.8E-14	1.6E+01	1.20E-15	1.6E+01	N/A	--	N/A	--	3.3E-15	1.6E+01	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01	27200.0	--	--	8.50E+01	30 min
POKVF	17	N/A	--	N/A	--	N/A	--	1.00E-14	1.6E+01	N/A	--	N/A	--	8.0E-16	1.6E+01	N/A	--	25600.0	--	--	4.00E+01	30 min
POSVF	17	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.0E-16	1.6E+01	3.3E-14	1.6E+01	21696.0	--	--	3.39E+01	30 min

See notes at end of table.

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
F018 - Indirect large aircraft crash damages the MDB; no fire																						
POBGS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	2640.0	--	--	6.10E+00	1 HR
POBHC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.5E-08	1.1E+01	4.0E-10	1.1E+01	N/A	--	1728.0	--	--	NS	1 HR
POCGC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--	230.4	--	--	1.04E-01	1 HR
POCHC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.5E-08	1.1E+01	N/A	--	N/A	--	460.8	--	--	NS	1 HR
POKGS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--	9000.0	--	--	6.80E+00	1 HR
POKHS	18	8.8E-09	1.1E+01	5.9E-10	1.1E+01	N/A	--	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	10200.0	--	--	NS	1 HR
POKVS	18	N/A	--	N/A	--	N/A	--	5.1E-09	1.1E+01	N/A	--	N/A	--	4.0E-10	1.1E+01	N/A	--	9600.0	--	--	NS	1 HR
POMVC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	2268.0	--	3.15E+01	NS	1 HR
POPGC	18	8.8E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	312.0	--	--	1.30E-01	1 HR
POPHC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	6.5E-08	1.1E+01	4.0E-10	1.1E+01	N/A	--	561.6	--	--	NS	1 HR
POPVC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	288.0	--	--	NS	1 HR
POBGC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	522.0	--	--	1.99E-01	1 HR
POOVC	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	522.0	--	--	NS	1 HR
PORGC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	963.0	--	2.14E+01	5.44E-01	1 HR
PORVC	18	8.8E-09	1.1E+01	N/A	--	5.0E-09	1.1E+01	N/A	--	1.7E-09	1.1E+01	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	900.0	--	2.00E+01	NS	1 HR
POSVS	18	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.0E-10	1.1E+01	1.7E-08	1.1E+01	8136.0	--	--	NS	1 HR
P019 - Indirect large aircraft crash damages the MDB; fire not contained in 0.5 hours																						
FOBGF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01	2640.0	--	--	2.64E+02	1 HR
PODHC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-08	1.1E+01	3.3E-10	1.1E+01	N/A	--	1728.0	--	4.32E+02	6.48E+01	20 MIN
FOCGC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--	230.4	--	5.76E+01	1.73E+01	20 MIN
POCHC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-08	1.1E+01	N/A	--	N/A	--	460.8	--	1.15E+02	1.73E+01	20 MIN
POKGF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--	9000.0	--	--	9.00E+02	1 HR
POKHF	19	7.1E-09	1.1E+01	4.8E-10	1.1E+01	N/A	--	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01	10200.0	--	--	5.10E+02	1 HR
POKVF	19	N/A	--	N/A	--	N/A	--	4.2E-09	1.1E+01	N/A	--	N/A	--	3.3E-10	1.1E+01	N/A	--	9600.0	--	--	2.40E+02	1 HR
POMVC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	2268.0	--	5.67E+02	4.25E+01	20 MIN
FOPGC	19	7.2E-09	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	312.0	--	7.80E+01	2.34E+01	20 MIN
FOPHC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	5.4E-08	1.1E+01	3.3E-10	1.1E+01	N/A	--	561.6	--	1.40E+02	2.11E+01	20 MIN
FOPVC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	288.0	--	7.20E+01	5.40E+00	20 MIN
FOBGC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	522.0	--	1.31E+02	3.92E+01	20 MIN

See notes at end of table.

PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
PODVC	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	522.0	--	1.31E+02	9.79E+00	20 MIN
PORGC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	963.0	--	2.41E+02	7.22E+01	20 MIN
PORVC	19	7.2E-09	1.1E+01	N/A	--	4.1E-09	1.1E+01	N/A	--	1.4E-09	1.1E+01	N/A	--	3.3E-10	1.1E+01	1.4E-08	1.1E+01	900.0	--	2.25E+02	1.69E+01	20 MIN
POSVF	19	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-10	1.1E+01	3.3E-10	1.1E+01	8136.0	--	--	2.03E+02	1 HR
PG20 - Indirect large aircraft crash damages the MDB; fire contained in 0.5 hours																						
PORGF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01	2640.0	--	--	9.70E+00	30 MIN
POVGF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	N/A	--	9000.0	--	--	9.60E+00	30 MIN
PORHF	20	2.4E-12	1.4E+01	1.6E-13	1.4E+01	N/A	--	N/A	--	4.6E-13	1.4E+01	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01	10200.0	--	--	2.70E+00	30 MIN
PORVF	20	N/A	--	N/A	--	N/A	--	1.4E-12	1.4E+01	N/A	--	N/A	--	1.1E-13	1.4E+01	N/A	--	9600.0	--	--	7.00E-01	30 MIN
POSVF	20	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.1E-13	1.4E+01	4.6E-12	1.4E+01	8136.0	--	--	7.00E-01	30 MIN
PO21 - Large or small direct aircraft crash damages the outdoor agent piping system at TEAD; no fire																						
POAGS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--	548.0	5.48E+02	--	--	1 HR
POAHS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--	636.0	6.36E+02	--	--	1 HR
POAVS	21	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-08	1.0E+01	N/A	--	507.0	5.07E+02	--	--	1 HR
PO22 - Large or small direct aircraft crash damages the outdoor agent piping system at TEAD; fire occurs																						
POAGS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.2E-09	1.0E+01	N/A	--	548.0	--	--	5.48E+01	10 MIN
POAHS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.2E-09	1.0E+01	N/A	--	638.0	--	--	3.19E+01	10 MIN
POAVS	22	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.2E-09	1.0E+01	N/A	--	507.0	--	--	1.27E+01	10 MIN

Notes:

1. Frequency unit = events/operating year
2. Scenarios 21 and 22 apply only to the TEAD bulk-only facility

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
PO25 - Earthquake damages the MDB structure, munitions fall & puncture; fire suppressed																						
POBGC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.9E-07	7.2E+00	9.0E-09	6.6E+00	2640.0	--	--	2.20E+01	6 HR
PODHC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--	1728.0	--	--	3.00E-01	6 HR
POCGC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	230.4	--	--	2.00E-01	6 HR
POCHC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	N/A	--	460.8	--	--	1.60E-01	6 HR
POKGC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-06	7.2E+00	N/A	--	9000.0	--	--	1.50E+02	6 HR
POKHC	25	7.1E-08	6.6E+00	2.1E-07	7.3E+00	N/A	--	N/A	--	7.1E-08	6.6E+00	N/A	--	1.6E-06	7.2E+00	7.1E-08	6.6E+00	10200.0	--	--	8.50E+01	6 HR
POKVC	25	N/A	--	N/A	--	N/A	--	9.9E-07	7.8E+00	N/A	--	N/A	--	1.6E-06	7.2E+00	N/A	--	9600.0	--	--	4.00E+01	6 HR
POMVC	25	2.3E-09	6.0E+00	N/A	--	N/A	--	N/A	--	2.3E-09	6.0E+00	N/A	--	5.0E-08	6.7E+00	2.3E-09	6.0E+00	2268.0	--	--	2.60E-01	6 HR
POPGC	25	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	312.0	--	--	6.50E-01	6 HR
POPHC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--	NEGL	--	N/A	--	561.6	--	--	5.90E-01	6 HR
POPVC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--	288.0	--	--	1.50E-01	6 HR
POQGC	25	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--	522.0	--	--	2.70E-01	6 HR
POQVC	25	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	522.0	--	--	3.60E-01	6 HR
PORGC	25	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	3.3E-07	6.7E+00	1.5E-08	6.0E+00	963.0	--	--	1.10E+00	6 HR
PORVC	25	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	1.5E-08	6.0E+00	N/A	--	3.3E-07	6.7E+00	1.5E-08	6.0E+00	900.0	--	--	2.50E-01	6 HR
POSVC	25	3.9E-07	6.6E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8.4E-06	7.2E+00	3.9E-07	6.6E+00	8136.0	--	--	3.40E+01	6 HR
PO26 - Earthquake damages the MDB structure, munitions fall & puncture; earthquake initiates fire; fire suppression system fails.																						
POBGC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	6.1E-09	1.3E+01	2.3E-10	1.1E+01	2640.0	--	--	2.64E+02	6 HR
PODHC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--	1728.0	--	4.32E+02	6.48E+01	6 HR
POCGC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	230.4	--	5.76E+01	1.73E+01	6 HR
POCHC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	N/A	--	460.8	--	1.15E+02	1.73E+01	6 HR
POKGC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.9E-08	1.3E+01	N/A	--	9000.0	--	--	9.00E+02	6 HR
POKHC	26	1.8E-09	1.1E+01	2.9E-08	1.5E+01	N/A	--	N/A	--	1.8E-09	1.1E+01	N/A	--	4.9E-08	1.3E+01	1.8E-09	1.1E+01	10200.0	--	--	5.10E+02	6 HR
POKVC	26	N/A	--	N/A	--	N/A	--	1.5E-07	1.6E+01	N/A	--	N/A	--	4.9E-08	1.3E+01	N/A	--	9600.0	--	--	2.40E+02	6 HR
POMVC	26	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	N/A	--	NEGL	--	NEGL	--	2268.0	--	5.67E+02	4.25E+01	6 HR
POPGC	26	NEGL	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	312.0	--	7.80E+01	2.34E+01	6 HR
POPHC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	NEGL	--	NEGL	--	N/A	--	561.6	--	1.40E+02	2.11E+01	6 HR
POPVC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	288.0	--	7.20E+01	5.40E+00	6 HR
POQGC	26	NEGL	--	N/A	--	NEGL	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	522.0	--	1.31E+02	3.92E+01	6 HR

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.I	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
FOQVC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	NEGL	--	NEGL	--	522.0	--	1.31E+02	9.79E+00	6 HR
PORGC	26	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	1.0E-08	1.4E+01	4.0E-10	1.0E+01	963.0	--	2.41E+02	7.22E+01	6 HR
PORVC	26	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	4.0E-10	1.0E+01	N/A	--	1.0E-08	1.4E+01	4.0E-10	1.0E+01	900.0	--	2.25E+02	1.69E+01	6 HR
FOSVC	26	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.7E-07	1.3E+01	9.9E-09	1.1E+01	8136.0	--	--	2.03E+02	6 HR
PO29 - Earthquake damages the MDB; munitions are intact; fire occurs; fire suppression system fails.																						
POBGC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	2640.0	--	--	2.64E+02	6 HR
FODHC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	2.2E-05	1.0E+01	N/A	--	1728.0	--	4.32E+02	6.48E+01	6 HR
POCGC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--	230.4	--	5.76E+01	1.73E+01	6 HR
FOCHC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	460.8	--	1.15E+02	1.73E+01	6 HR
POKGC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--	9000.0	--	--	9.00E+02	6 HR
POKHC	29	7.8E-07	8.8E+00	2.3E-05	8.5E+00	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	10200.0	--	--	5.10E+02	6 HR
FOKVC	29	N/A	--	N/A	--	N/A	--	1.2E-04	8.5E+00	N/A	--	N/A	--	2.2E-05	1.0E+01	N/A	--	9600.0	--	--	2.40E+02	6 HR
POMVC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	2268.0	--	5.67E+02	4.25E+01	6 HR
FOPGC	29	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	312.0	--	7.80E+01	2.34E+01	6 HR
FOPHC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	7.8E-07	8.8E+00	2.2E-05	1.0E+01	N/A	--	561.6	--	1.40E+02	2.11E+01	6 HR
PCPVC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	288.0	--	7.20E+01	5.40E+00	6 HR
POQGC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	522.0	--	1.31E+02	3.92E+01	6 HR
POQVC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	522.0	--	1.31E+02	9.79E+00	6 HR
FORGC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	963.0	--	2.41E+02	7.22E+01	6 HR
FORVC	29	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	7.8E-07	8.8E+00	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	900.0	--	2.25E+02	1.69E+01	6 HR
FOSVC	29	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-05	1.0E+01	7.8E-07	8.8E+00	8136.0	--	--	2.03E+02	6 HR
PO33 - Earthquake causes munitions to fall but no detonation occurs; the MDB is intact; the TOX is intact; earthquake initiates fire; fire suppression system fails.																						
FOBGC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2640.0	--	--	2.64E+02	6 HR
FODHC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	4.8E-05	2.0E+01	N/A	--	1728.0	--	4.32E+02	6.48E+01	6 HR
POCGC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	N/A	--	230.4	--	5.76E+01	1.73E+01	6 HR
PCCHC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	460.8	--	1.15E+02	1.73E+01	6 HR
POKGC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9000.0	--	--	9.00E+02	6 HR
POKHC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	10200.0	--	--	5.10E+02	6 HR
POKVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	9600.0	--	--	2.40E+02	6 HR
POMVC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	2268.0	--	5.67E+02	4.25E+01	6 HR

See notes at end of table.

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PLANT OPERATIONS - EXTERNAL INITIATING EVENTS
MEDIAN ACCIDENT FREQUENCY (PER YEAR)

SCENARIO I.D.	NO.	AMAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAF FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT RELEASE TOTAL AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
POPGC	33	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	312.0	--	7.80E+01	2.34E+01	6 HR
FOPHC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	1.7E-06	2.0E+01	4.8E-05	2.0E+01	N/A	--	561.6	--	1.40E+02	2.11E+01	6 HR
FOPVC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	288.0	--	7.20E+01	5.40E+00	6 HR
POQGC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	522.0	--	1.31E+02	3.92E+01	6 HR
POQVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	522.0	--	1.31E+02	9.79E+00	6 HR
FORGC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	963.0	--	2.41E+02	7.22E+01	6 HR
PORVC	33	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	1.7E-06	2.0E+01	N/A	--	4.8E-05	2.0E+01	1.7E-06	2.0E+01	900.0	--	2.25E+02	1.69E+01	6 HR
POSVC	33	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	8136.0	--	--	2.03E+02	6 HR

Notes:

1. Frequency unit = events/operating year

I.1.4. ONSITE TRANSPORT

The following tables list the accident results for onsite transport of munitions.

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ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors | Agent Available and Released

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
VOBGS	1	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	1760.0	2.2E+02	--	--	2 HRS
VODHS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--	1152.0	6.0E+00	--	--	2 HRS
VOCGS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	153.6	1.6E+00	--	--	2 HRS
VOCHS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	307.2	3.2E+00	--	--	2 HRS
VOKGS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	6000.0	1.5E+03	--	--	2 HRS
VOKHS	1	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	6800.0	1.7E+03	--	--	2 HRS
VOKVS	1	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	6400.0	1.6E+03	--	--	2 HRS
VOMVS	1	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	1512.0	1.0E+01	--	--	2 HRS
VOPGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	208.0	6.5E+00	--	--	2 HRS
VOPHS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	N/A	--	374.4	1.2E+01	--	--	2 HRS
VOPVS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	192.0	6.0E+00	--	--	2 HRS
VOEGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	348.0	1.5E+01	--	--	2 HRS
VOBVS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	348.0	1.5E+01	--	--	2 HRS
VORGS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	642.0	1.1E+01	--	--	2 HRS
VORVS	1	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	600.0	1.0E+01	--	--	2 HRS
VOSVS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	1.4E-08	2.2E+01	2712.0	1.4E+03	--	--	2 HRS
VOWGS	1	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.4E-08	2.2E+01	N/A	--	1392.0	3.5E+02	--	--	2 HRS
VOBGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	1760.0	2.2E+02	--	--	2 HRS
VODHS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--	1152.0	6.9E+00	--	--	2 HRS
VOCGS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	153.6	1.6E+00	--	--	2 HRS
VOCHS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	307.2	3.2E+00	--	--	2 HRS
VOKGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	6000.0	1.5E+03	--	--	2 HRS
VOKHS	3	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	6800.0	1.7E+03	--	--	2 HRS
VOKVS	3	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	6400.0	1.6E+03	--	--	2 HRS
VOMVS	3	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	1512.0	1.0E+01	--	--	2 HRS
VOPGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	208.0	6.5E+00	--	--	2 HRS
VOPHS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	N/A	--	374.4	1.2E+01	--	--	2 HRS
VOPVS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	192.0	6.0E+00	--	--	2 HRS
VOEGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	348.0	1.5E+01	--	--	2 HRS

See notes at end of table.

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ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors																		Agent Available and Released				
SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
VOQVS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	348.0	1.5E+01	--	--	2 HRS
VORGS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	642.0	1.1E+01	--	--	2 HRS
VORVS	3	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	600.0	1.0E+01	--	--	2 HRS
VOSVS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	5.4E-11	2.6E+01	2712.0	1.4E+03	--	--	2 HRS
VOWGS	3	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	5.4E-11	2.6E+01	N/A	--	1392.0	3.5E+02	--	--	2 HRS
VODHC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	N/A	--	1152.0	--	2.9E+02	4.3E+01	20 MIN
VOCGC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--	153.6	--	3.8E+01	1.2E+01	20 MIN
VOCHC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	307.2	--	7.7E+01	1.2E+01	20 MIN
VOMVC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	1512.0	--	3.8E+02	4.5E+02	20 MIN
VOPGC	4	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	208.0	--	5.2E+01	2.6E+02	20 MIN
VOPHC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	N/A	--	374.4	--	9.4E+01	1.2E+02	20 MIN
VOPVC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	192.0	--	4.8E+01	2.8E+01	20 MIN
VOQGC	4	3.0E-12	1.4E+02	N/A	--	3.0E-12	1.4E+02	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	348.0	--	8.7E+01	1.6E+01	20 MIN
VOQVC	4	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.0E-12	1.4E+02	3.0E-12	1.4E+02	348.0	--	8.7E+01	1.4E+01	20 MIN
VORGC	4	2.8E-10	3.3E+01	N/A	--	2.8E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	2.8E-10	3.3E+01	642.0	--	1.6E+02	3.6E+00	20 MIN
VORVC	4	2.8E-10	3.3E+01	N/A	--	2.8E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	N/A	--	2.2E-10	3.3E+01	2.8E-10	3.3E+01	600.0	--	1.5E+02	2.6E+01	20 MIN
VOBGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02	1760.0	--	--	1.8E+02	1 HR
VOKGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	6000.0	--	--	6.0E+02	1 HR
VOKHF	5	2.8E-14	1.6E+02	2.8E-14	1.6E+02	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02	6800.0	--	--	3.4E+02	1 HR
VOKVF	5	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	6400.0	--	--	1.6E+02	1 HR
VOSVF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	2.8E-14	1.6E+02	2712.0	--	--	6.8E+01	1 HR
VOWGF	5	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.8E-14	1.6E+02	N/A	--	1392.0	--	--	1.4E+02	1 HR
VOBGS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	1760.0	1.5E+03	--	--	2 HRS
VODHC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-09	2.0E+01	1.6E-10	2.0E+01	N/A	--	1152.0	8.1E+02	1.7E+02	--	2 HRS
VOCGC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--	153.6	1.1E+02	2.3E+01	--	2 HRS
VOCHC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	4.7E-09	2.0E+01	N/A	--	N/A	--	307.2	2.2E+02	4.6E+01	--	2 HRS
VOKGS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--	6000.0	5.1E+03	--	--	2 HRS
VOKHS	6	6.0E-10	2.0E+01	7.2E-08	2.0E+01	N/A	--	N/A	--	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	6800.0	5.8E+03	--	--	2 HRS
VOKVS	6	N/A	--	N/A	--	N/A	--	5.0E-10	2.0E+01	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--	6400.0	5.4E+03	--	--	2 HRS

See notes at end of table.

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors

Agent Available and Released

SCEN-ARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
-----	---	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------
VOMVC	6	6.0E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	1512.0	1.1E+03	2.3E+02	--	2 HRS
VOPGC	6	6.0E-10	2.0E+01	N/A	--	N/A		N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	208.0	1.5E+02	3.1E+01	--	2 HRS
VOPHC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--	N/A	--	4.7E-08	2.0E+01	1.6E-10	2.0E+01	N/A	--	374.4	2.6E+02	5.6E+01	--	2 HRS
VOPVC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	192.0	1.3E+02	2.9E+01	--	2 HRS
VOQGC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	348.0	2.4E+02	5.2E+01	--	2 HRS
VOEVC	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	348.0	2.4E+02	5.2E+01	--	2 HRS
VORGC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	642.0	4.5E+02	9.6E+01	--	2 HRS
VORVC	6	6.0E-10	2.0E+01	N/A	--	2.7E-10	2.0E+01	N/A	--	1.1E-09	2.0E+01	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	600.0	4.2E+02	9.0E+01	--	2 HRS
VOSVS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	1.0E-09	2.0E+01	2712.0	2.3E+03	--	--	2 HRS
VOWGS	6	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.6E-10	2.0E+01	N/A	--	1392.0	1.2E+03			2 HRS
VOBGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	1.8E+03	--	--	1.8E+02	1 HR
VODHC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-09	2.0E+01	1.3E-10	2.0E+01	N/A	--	1.2E+03	--	2.9E+02	4.3E+01	20 MIN
VOCGC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--	1.5E+02	--	3.8E+01	1.2E+01	20 MIN
VOCHC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-09	2.0E+01	N/A	--	N/A	--	3.1E+02	--	7.7E+01	1.2E+01	20 MIN
VOKGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--	6.0E+03	--	--	6.0E+02	1 HR
VOKHF	7	4.9E-10	2.0E+01	5.9E-08	2.0E+01	N/A	--	N/A	--	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	6.8E+03	--	--	3.4E+02	1 HR
VOKVF	7	N/A	--	N/A	--	N/A	--	4.1E-10	2.0E+01	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--	6.4E+03	--	--	1.6E+02	1 HR
VOMVC	7	4.9E-10	2.0E+01	N/A	--	N/A	--	N/A	--	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	1.5E+03	--	3.8E+02	2.9E+01	20 MIN
VOPGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	2.1E+02	--	5.2E+01	1.6E+01	20 MIN
VOPHC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	N/A	--	3.9E-09	2.0E+01	1.3E-10	2.0E+01	N/A	--	3.7E+02	--	9.4E+01	1.4E+01	20 MIN
VOPVC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	1.9E+02	--	4.8E+01	3.6E+00	20 MIN
VOQGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	3.5E+02	--	8.7E+01	2.6E+01	20 MIN
VOQVC	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	6.4E-10	2.0E+01	3.5E+02	--	6.7E+01	6.5E+00	20 MIN
VORGC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	6.4E+02	--	1.6E+02	4.8E+01	20 MIN
VORVC	7	4.9E-10	2.0E+01	N/A	--	2.3E-10	2.0E+01	N/A	--	9.1E-10	2.0E+01	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	6.0E+02	--	1.5E+02	1.1E+01	20 MIN
VOSVF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	8.4E-10	2.0E+01	2.7E+03	--	--	6.8E+01	1 HR
VOWGF	7	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.3E-10	2.0E+01	N/A	--	1.4E+03	--	--	1.4E+02	1 HR
VOBGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	1760.0	2.2E+02	--	--	2 HRS
VODHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	1.0E-05	1.1E+01	N/A	--	1152.0	6.0E+00	--	--	2 HRS

See notes at end of table.

File: ONSITREG.WK1 Page 4 Date 19-Aug-87

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors | Agent Available and Released

SCEN-ARIO	No.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
VOCGS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	--	N/A	--	153.6	1.6E+00	--	--	2 HRS
VOCHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	1.1E+01	N/A	--	307.2	3.2E+00	--	--	2 HRS
VOKGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--	6000.0	1.5E+03	--	--	2 HRS
VOKHS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	6800.0	1.7E+03	--	--	2 HRS
VOKVS	9	N/A	--	N/A	--	N/A	--	2.0E-06	1.1E+01	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--	6400.0	1.6E+03	--	--	2 HRS
VOMVS	9	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	1512.0	1.0E+01	--	--	2 HRS
VOPGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	208.0	6.5E+00	--	--	2 HRS
VOPHS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	6.0E-07	1.1E+01	1.0E-05	1.1E+01	N/A	--	374.4	1.2E+01	--	--	2 HRS
VOPVS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	192.0	6.0E+00	--	--	2 HRS
VOQGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	348.0	1.5E+01	--	--	2 HRS
VOQVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	348.0	1.5E+01	--	--	2 HRS
VORGS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	642.0	1.1E+01	--	--	2 HRS
VORVS	9	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	6.0E-07	1.1E+01	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	600.0	1.0E+01	--	--	2 HRS
VOSVS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	6.0E-07	1.1E+01	2712.0	1.4E+03	--	--	2 HRS
VOWGS	9	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	1.0E-05	1.1E+01	N/A	--	1392.0	3.5E+02	--	--	2 HRS
VOBGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	1760.0	2.2E+02	--	--	6 HRS
VODHS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	3.9E-08	1.4E+01	N/A	--	1152.0	6.0E+00	--	--	6 HRS
VOCGS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--	153.6	1.6E+00	--	--	6 HRS
VOCHS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	307.2	3.2E+00	--	--	6 HRS
VOKGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--	6000.0	1.5E+03	--	--	6 HRS
VOKHS	11	2.4E-09	1.4E+01	2.4E-09	1.4E+01	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	6800.0	1.7E+03	--	--	6 HRS
VOKVS	11	N/A	--	N/A	--	N/A	--	7.9E-09	1.4E+01	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--	6400.0	1.6E+03	--	--	6 HRS
VOMVS	11	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	1512.0	1.0E+01	--	--	6 HRS
VOPGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	208.0	6.5E+00	--	--	6 HRS
VOPHS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	2.4E-09	1.4E+01	3.9E-08	1.4E+01	N/A	--	374.4	1.2E+01	--	--	6 HRS
VOPVS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	192.0	6.0E+00	--	--	6 HRS
VOQGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	348.0	1.5E+01	--	--	6 HRS
VOQVS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	348.0	1.5E+01	--	--	6 HRS
VORGS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	642.0	1.1E+01	--	--	6 HRS

See notes at end of table.

File: ONSITFEQ.WK1 Page 5 Date 19-Aug-87

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors

Agent Available and Released

SCEN-ARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
VORVS	11	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	2.4E-09	1.4E+01	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	600.0	1.0E+01	--	--	6 HRS
VOSVS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	2.4E-09	1.4E+01	2712.0	1.4E+03	--	--	6 HRS
VOMGS	11	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.9E-08	1.4E+01	N/A	--	1392.0	3.5E+02	--	--	6 HRS
VODHC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	7.1E-12	8.8E+01	N/A	--	1.2E+03	--	2.9E+02	4.3E+01	20 MIN
VOCGC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	N/A	--	1.5E+02	--	3.8E+01	1.2E+01	20 MIN
VOCHC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	3.1E+02	--	7.7E+01	1.2E+01	20 MIN
VOMVC	12	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	4.2E-13	1.0E+02	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02	1.5E+03	--	3.8E+02	2.8E+01	20 MIN
VOFGC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02	2.1E+02	--	5.2E+01	1.6E+01	20 MIN
VOPHC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	4.2E-13	1.0E+02	7.1E-12	8.8E+01	N/A	--	3.7E+02	--	9.4E+01	1.4E+01	20 MIN
VOPVC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02	1.9E+02	--	4.8E+01	3.6E+00	20 MIN
VOQGC	12	4.2E-13	1.0E+02	N/A	--	4.2E-13	1.0E+02	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02	3.5E+02	--	8.7E+01	2.6E+01	20 MIN
VOQVC	12	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	8.8E+01	4.2E-13	1.0E+02	3.5E+02	--	8.7E+01	6.5E+00	20 MIN
VORGC	12	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	2.0E-07	2.0E+01	1.2E-08	1.7E+01	6.4E+02	--	1.6E+02	4.8E+01	20 MIN
VORVC	12	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	1.2E-08	1.7E+01	N/A	--	2.0E-07	2.0E+01	1.2E-08	1.7E+01	6.0E+02	--	1.5E+02	1.1E+01	20 MIN
VOBGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02	1.8E+03	--	--	1.8E+02	1 HR
VOKGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--	6.0E+03	--	--	6.0E+02	1 HR
VOKHC	13	4.2E-13	1.1E+02	4.2E-13	1.1E+02	N/A	--	N/A	--	4.2E-13	1.1E+02	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02	6.8E+03	--	--	3.4E+02	1 HR
VOKVC	13	N/A	--	N/A	--	N/A	--	1.4E-12	1.2E+02	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--	6.4E+03	--	--	1.6E+02	1 HR
VOSVC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	4.2E-13	1.1E+02	1.4E+03	--	--	6.8E+01	1 HR
VOMGC	13	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	7.1E-12	1.0E+02	N/A	--	0.0E+00	--	--	1.4E+02	1 HR
VOBGC	14	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	1760.0	--	--	5.3E-01	2 HRS
VODHC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-08	1.2E+01	3.3E-09	1.3E+01	N/A	--	1152.0	--	--	2.4E-02	2 HRS
VOCGC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--	153.6	--	--	5.3E-01	2 HRS
VOCHC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	N/A	--	5.6E-08	1.2E+01	N/A	--	N/A	--	307.2	--	--	2.4E-02	2 HRS
VOKGS	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--	6000.0	9.0E+02	--	--	2 HRS
VOKHS	14	1.1E-06	1.0E+01	5.6E-08	1.2E+01	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	6800.0	1.0E+03	--	--	2 HRS
VOKVS	14	N/A	--	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	3.3E-09	1.3E+01	N/A	--	6400.0	9.6E+02	--	--	2 HRS
VOMVC	14	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	1512.0	--	--	2.0E-04	2 HRS
VOPGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	208.0	--	--	5.3E-01	2 HRS

See notes at end of table.

ONSITE TRANSPORTATION - ONSITE PACKAGE - ONSITE OPTION
(MOVEMENT FROM STORAGE TO DEMIL FACILITY IN ONSITE PACKAGE)

Scenario Frequencies and Range Factors | Agent Available and Released

SCEN-ARIO	NO.	ANAD FREQ	RANGE FACTOR	APG FREQ	RANGE FACTOR	LBAD FREQ	RANGE FACTOR	NAAP FREQ	RANGE FACTOR	PBA FREQ	RANGE FACTOR	PUDA FREQ	RANGE FACTOR	TEAD FREQ	RANGE FACTOR	UMDA FREQ	RANGE FACTOR	AGENT AVAILABLE	LBS. SPILLED	LBS. DETONATED	LBS. EMITTED	DURATION TIME
VOFHC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	5.6E-08	1.2E+01	3.3E-09	1.3E+01	N/A	--	374.4	--	--	2.4E-02	2 HRS
VOFVC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	192.0	--	--	2.0E-04	2 HRS
VOGGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	348.0	--	--	5.3E-01	2 HRS
VOGVC	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	348.0	--	--	2.0E-04	2 HRS
VORGC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	642.0	--	--	5.3E-01	2 HRS
VORVC	14	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	1.1E-06	1.0E+01	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	600.0	--	--	2.0E-04	2 HRS
VOSVS	14	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.3E+01	3.3E-09	1.3E+01	2712.0	1.4E+02	--	--	2 HRS
VOMGS	14	N/A		N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	3.3E-09	1.4E+01	N/A	--	1392.0	--	--	5.3E-01	2 HRS
VODHC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.5E-10	5.0E+01	2.2E-09	5.1E+01	N/A	--	1152.0	3.0E+01	6.0E+00	--	2 HRS
VOCGC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	N/A	--	153.6	8.0E+00	1.6E+00	--	2 HRS
VOCHC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	N/A	--	2.5E-10	5.0E+01	N/A	--	N/A	--	307.2	1.6E+01	3.2E+00	--	2 HRS
VOMVC	15	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.5E-10	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	1512.0	1.5E+02	3.2E+01	--	2 HRS
VOFGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	208.0	3.2E+01	6.5E+00	--	2 HRS
VOFHC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	2.5E-10	5.0E+01	2.2E-09	5.1E+01	N/A	--	374.4	5.8E+01	1.2E+01	--	2 HRS
VOFVC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	192.0	3.0E+01	6.0E+00	--	2 HRS
VOGGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	348.0	7.3E+01	1.5E+01	--	2 HRS
VOGVC	15	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	348.0	7.3E+01	1.5E+01	--	2 HRS
VORGC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	5.4E-15	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	642.0	6.2E+02	2.1E+01	--	2 HRS
VORVC	15	2.4E-09	4.2E+01	N/A	--	2.4E-09	4.2E+01	N/A	--	5.4E-15	4.2E+01	N/A	--	2.2E-09	5.1E+01	2.1E-11	5.1E+01	600.0	5.8E+02	2.0E+01	--	2 HRS

NOTES: 1. Scenarios 1-5 are per truck mile; scenarios 6-15 are per exposure year.
2. Duration time shown for scenarios with agent releases due to both detonations and spills is for spills only. Duration time for detonation is instantaneous.
3. Scenarios 4 and 15 frequencies are multiplied by a factor to account for new undue force value.

APPENDIX J
(Deleted)

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